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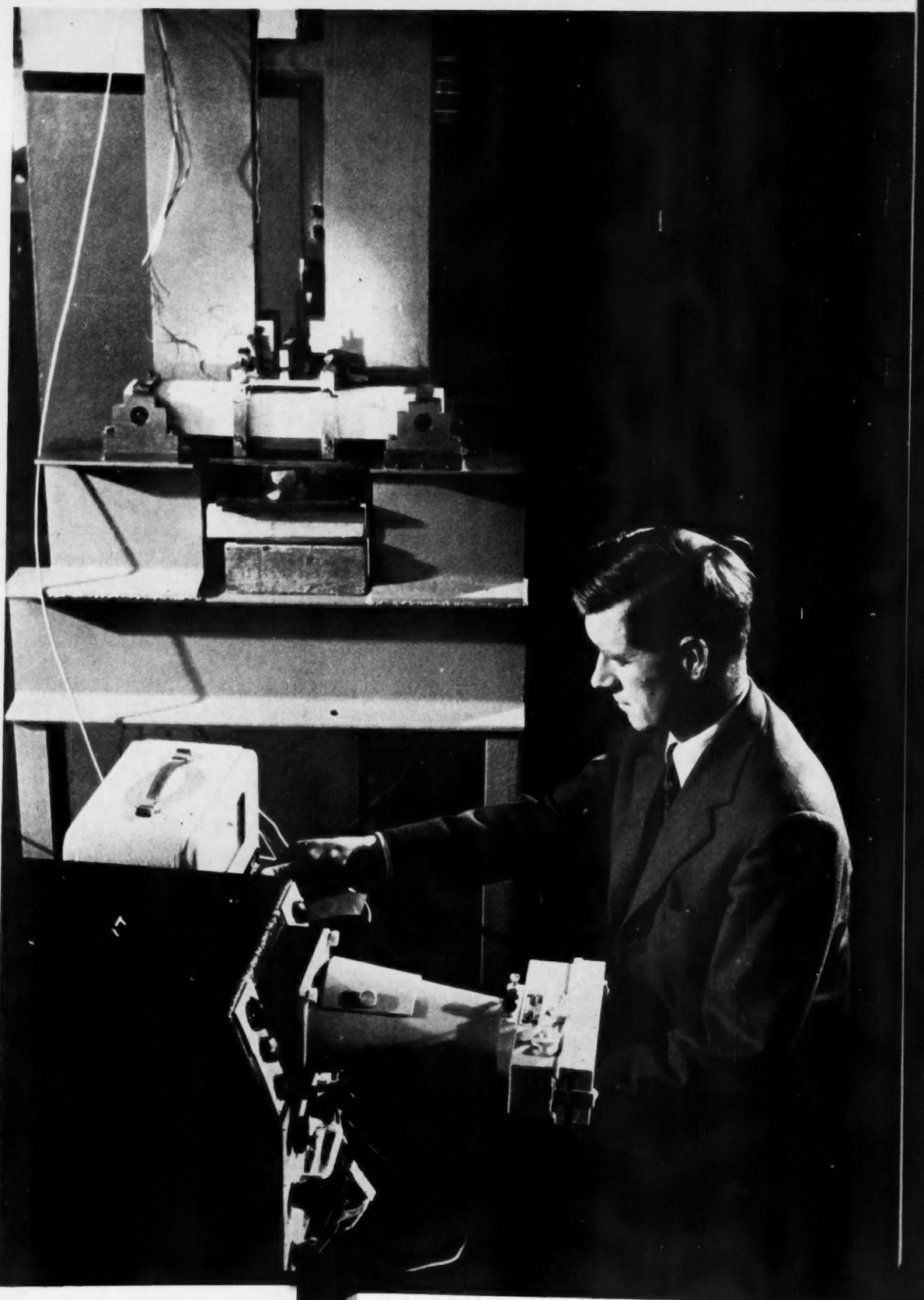

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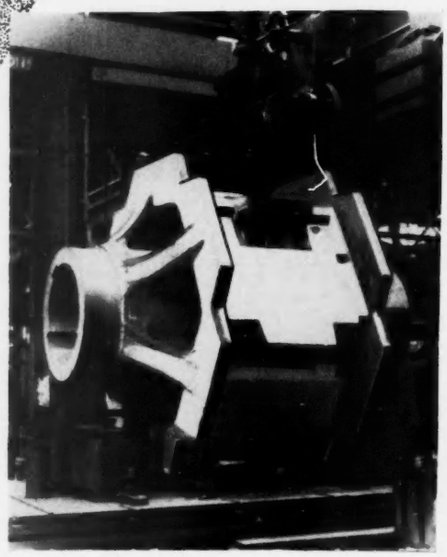
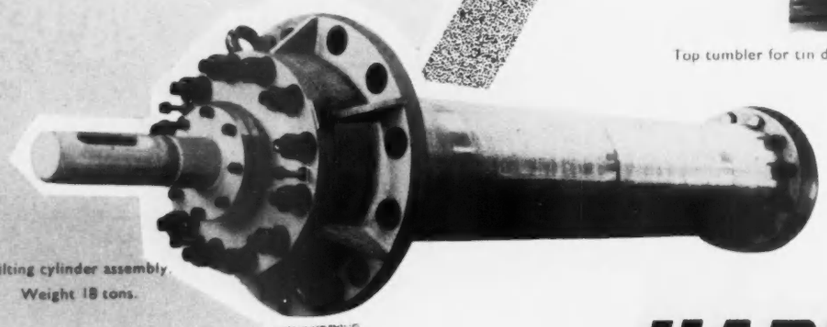


Top tumbler for tin dredging. Weight 17½ tons.



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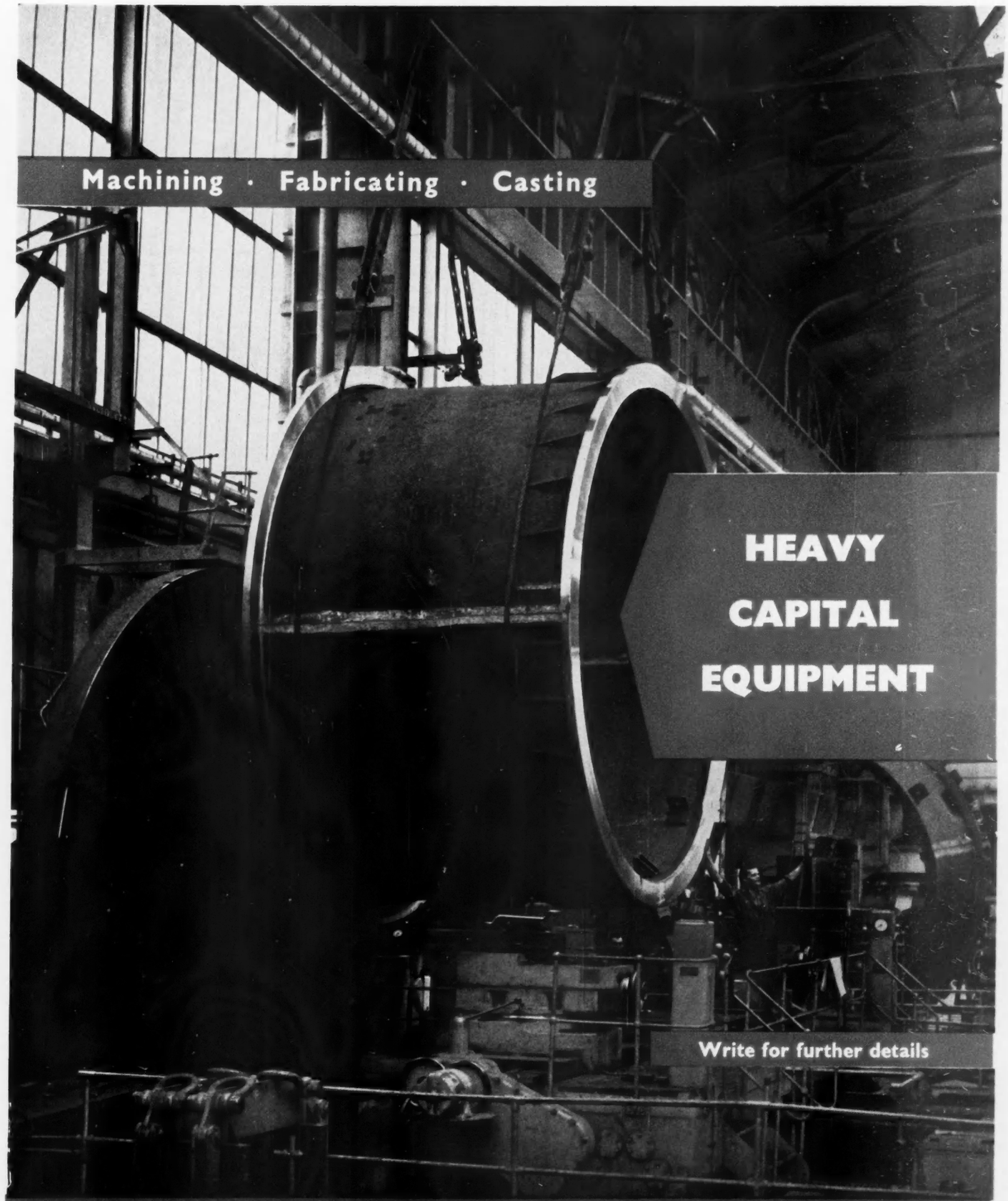

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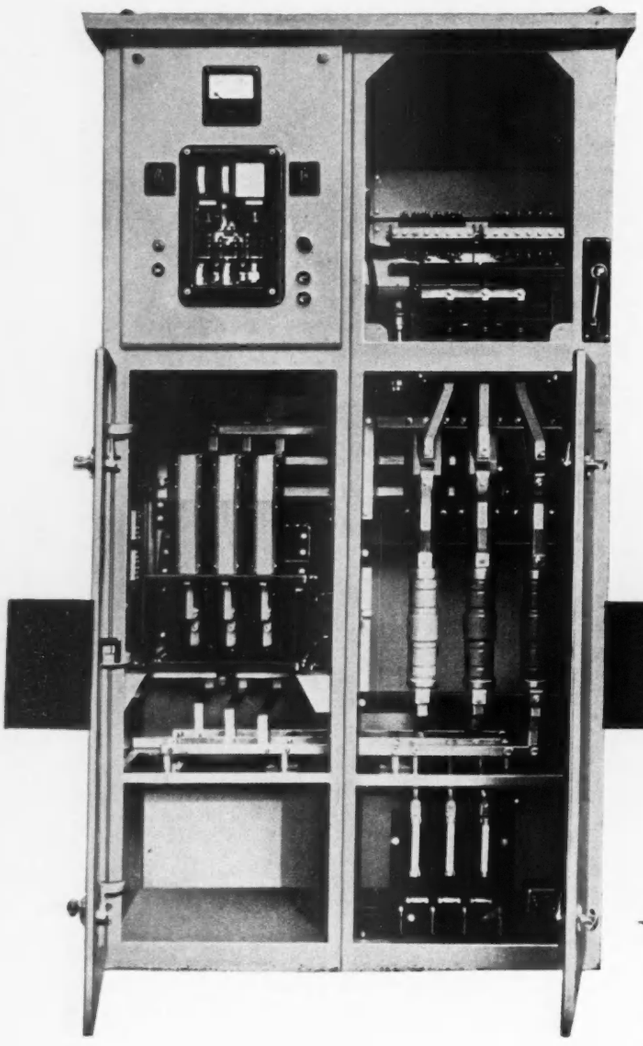

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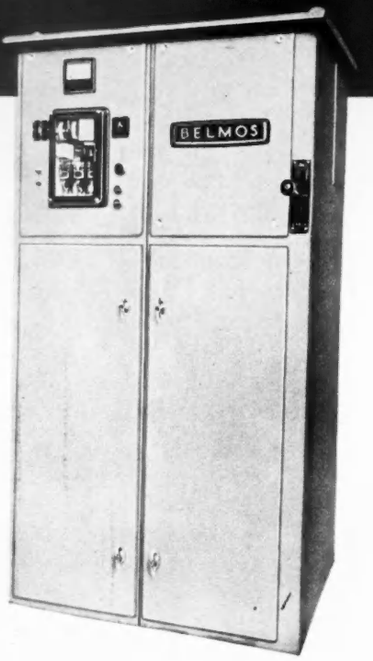

✶ *the type K starter is fully described and illustrated in leaflet J240 which is available on request.*

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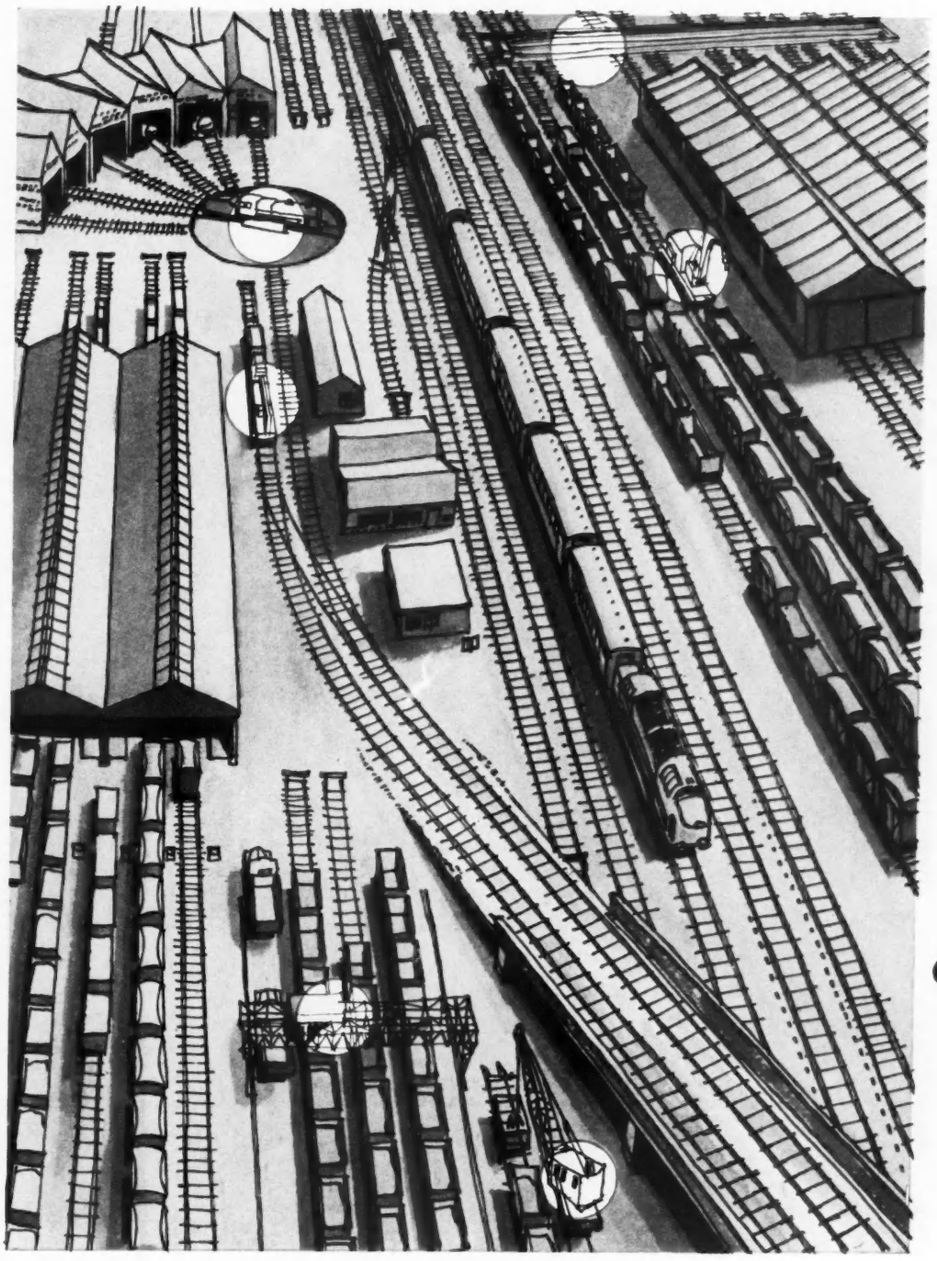

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A special purpose machine is being used at Cambridge University to test concrete beams under pulse loads. The strength under transient loading is significantly higher than the static strength. The tests contribute to the study of damage by blast. *Nurnberg photograph for* ENGINEERING.)

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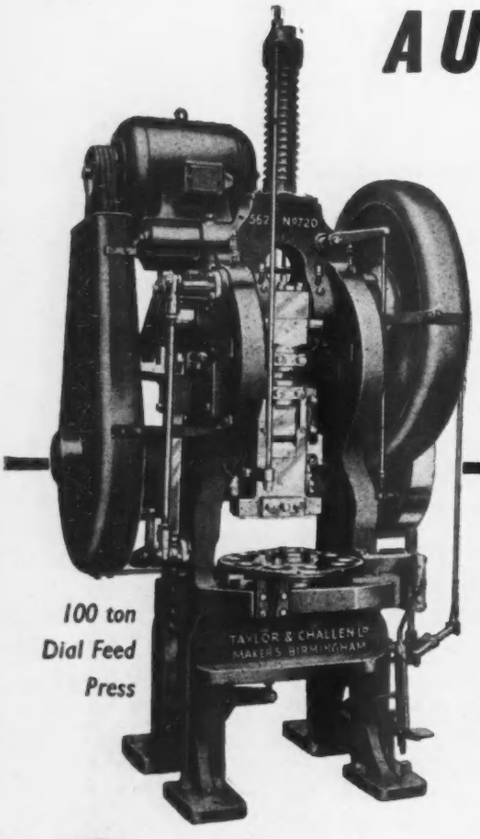

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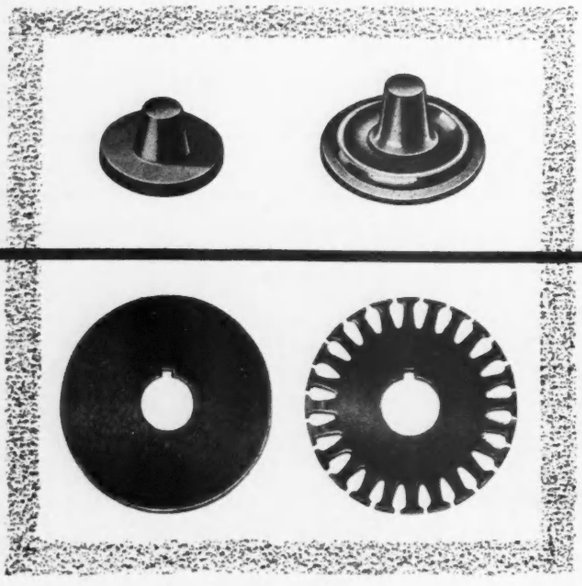

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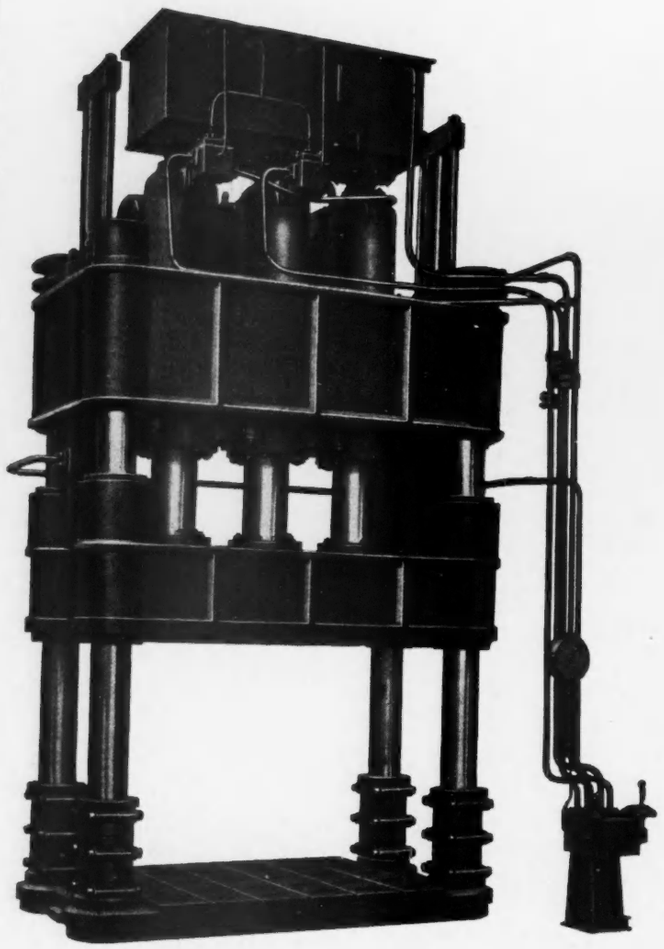

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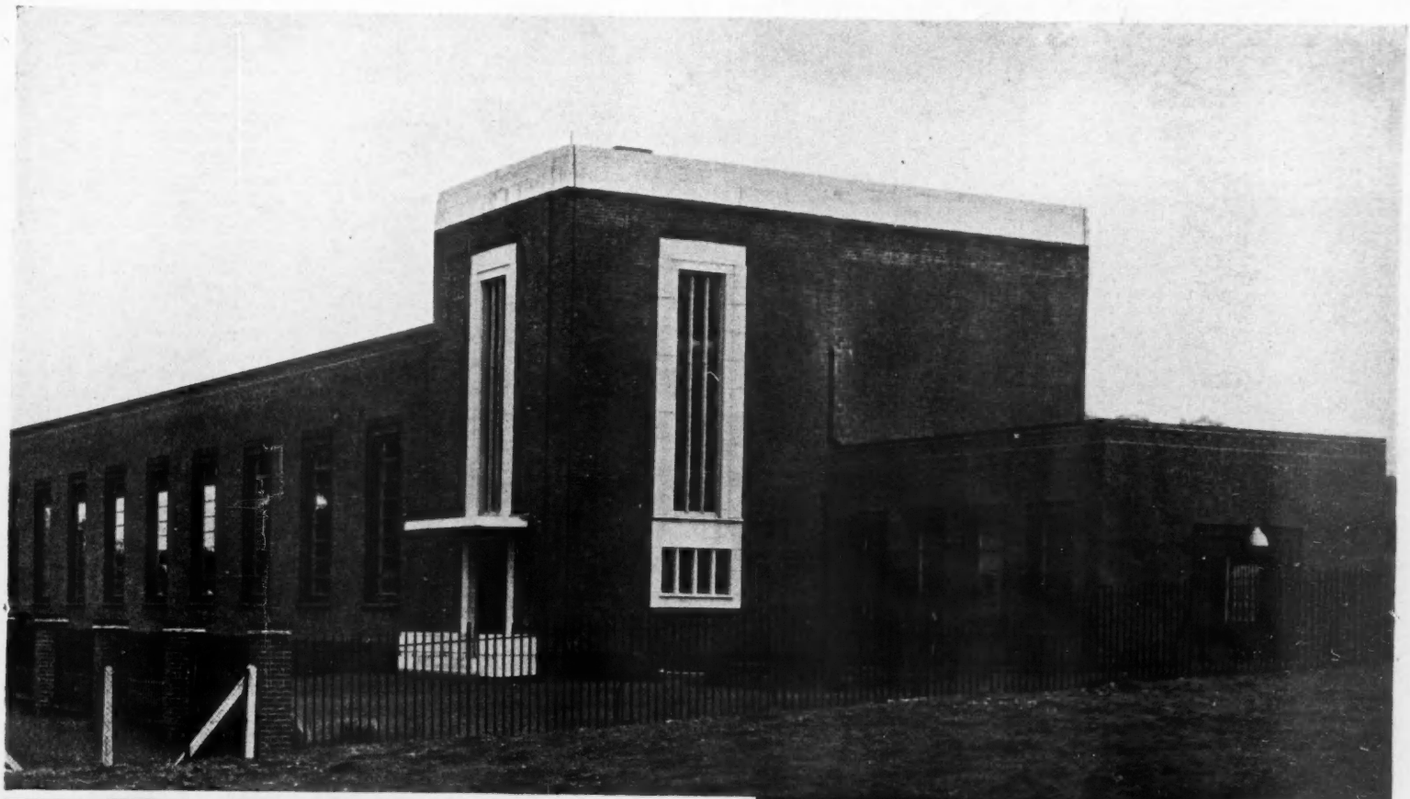

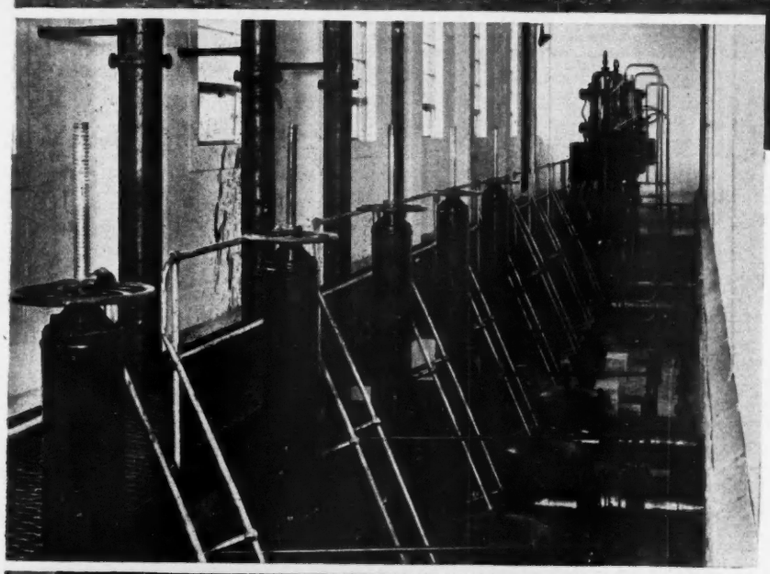

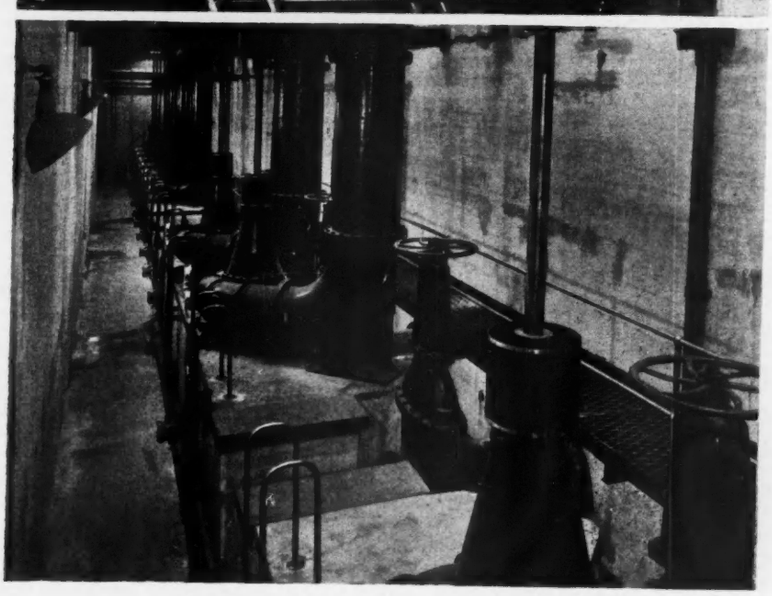

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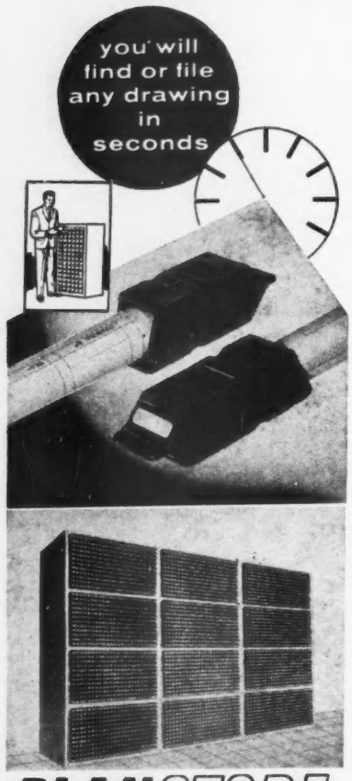

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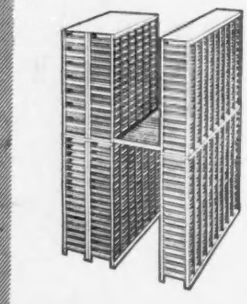

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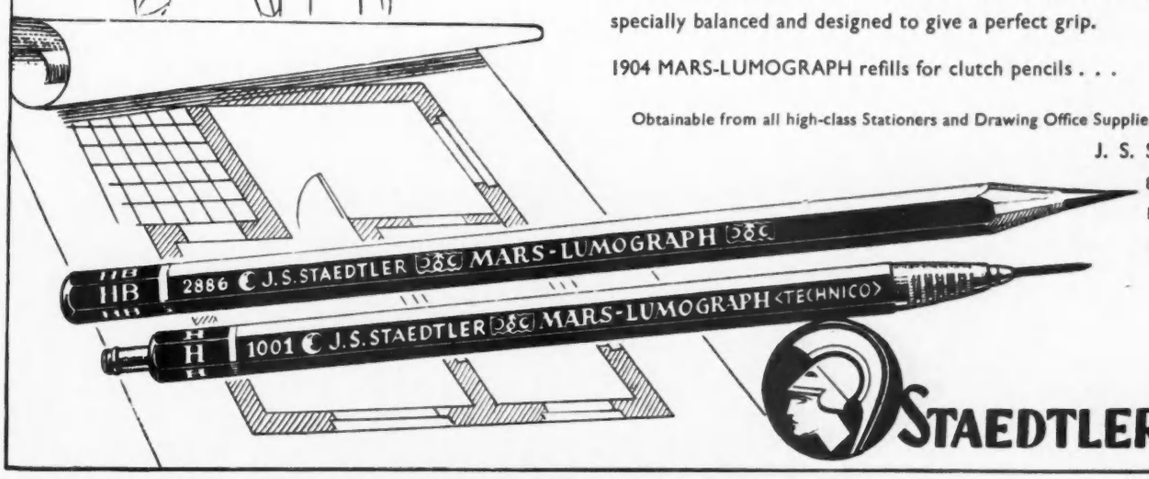

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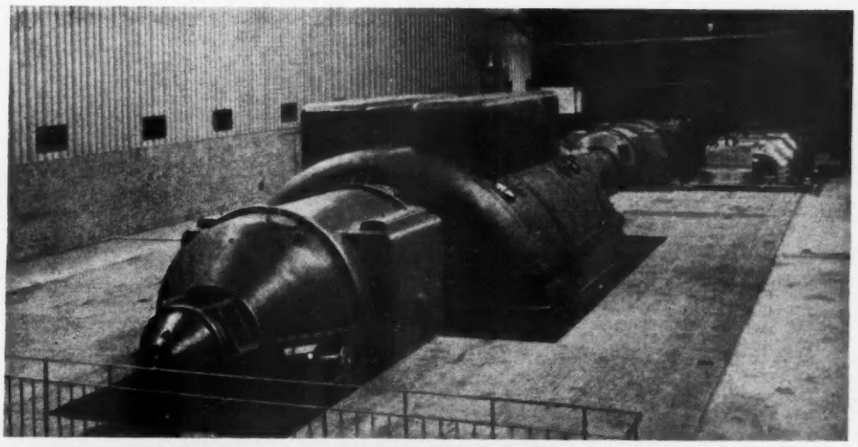

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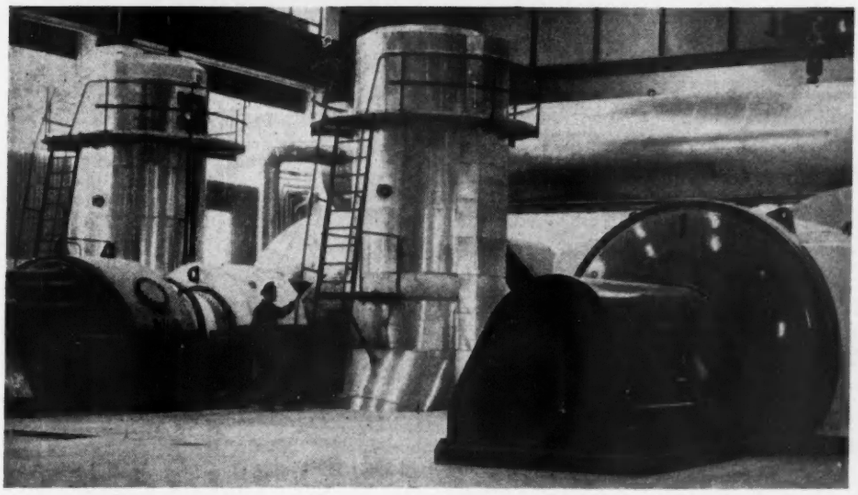

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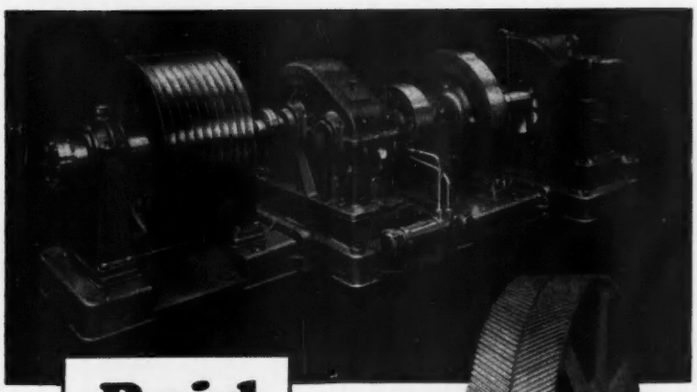

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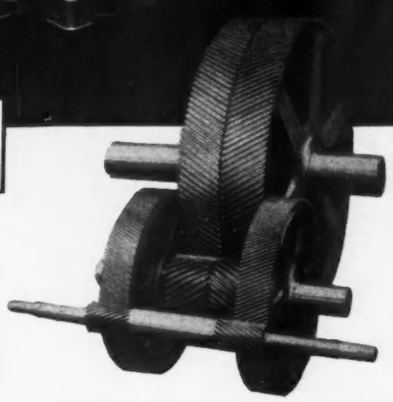

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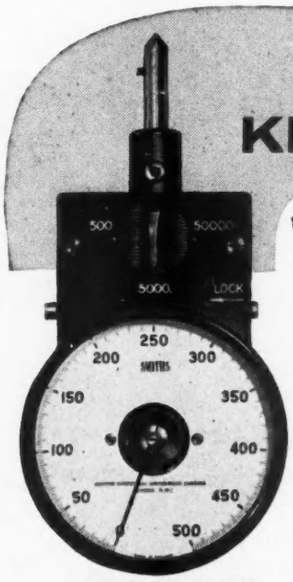

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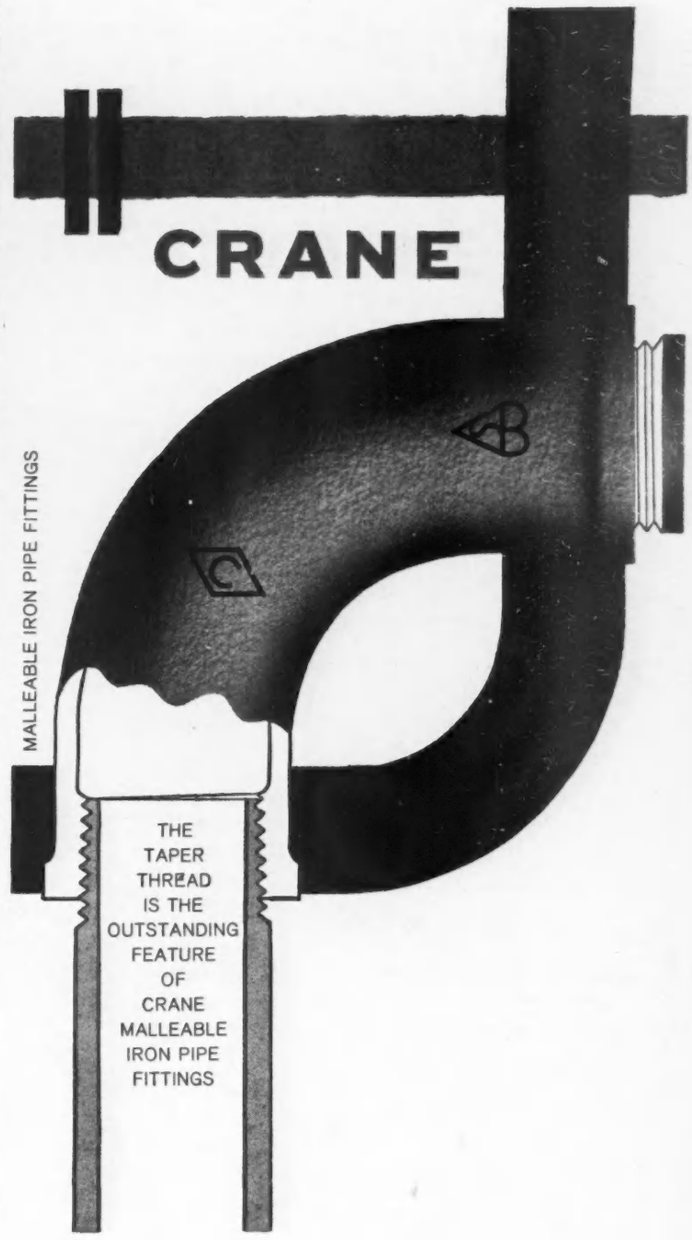

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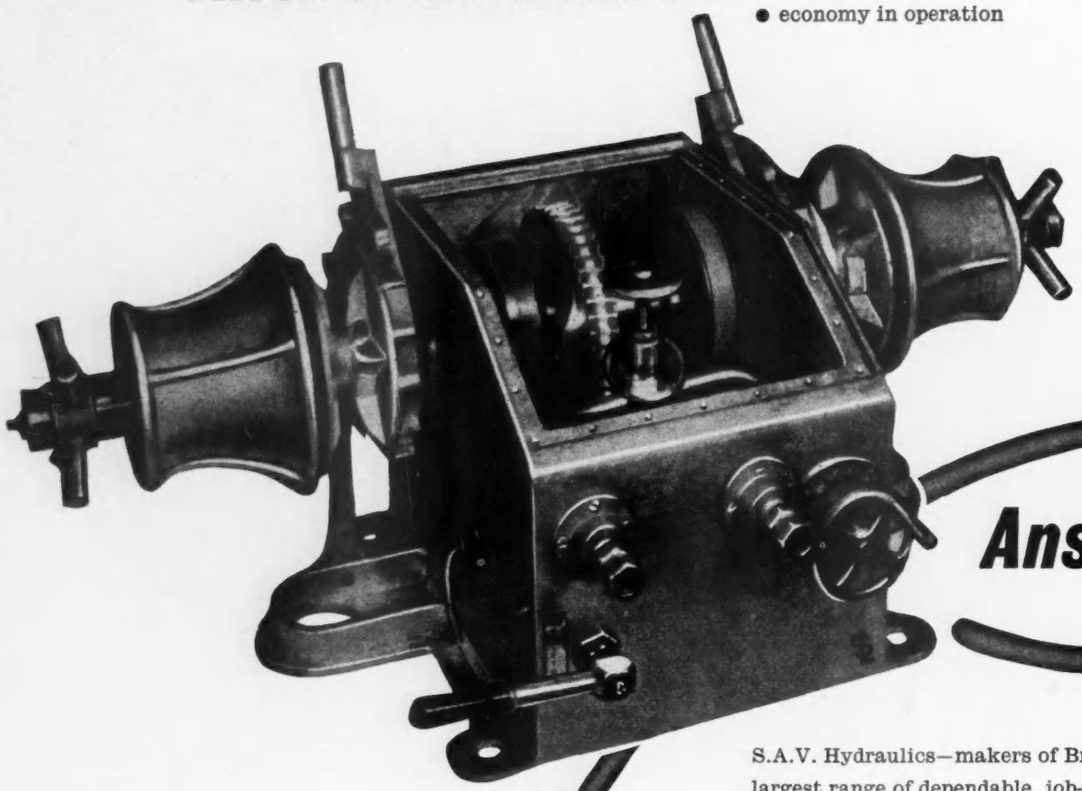

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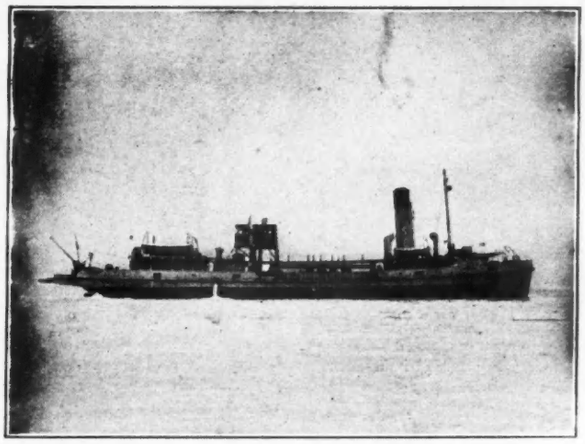

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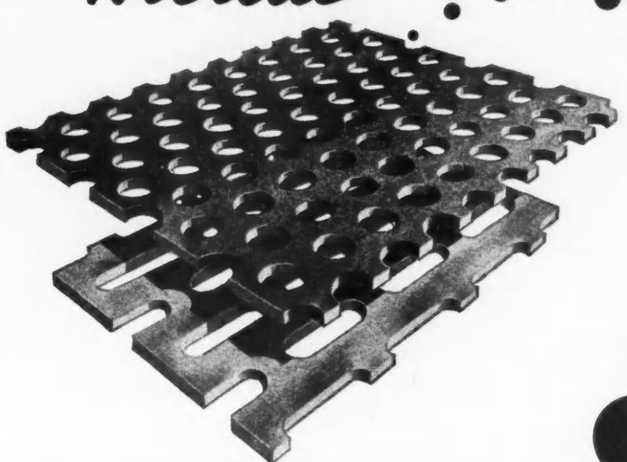

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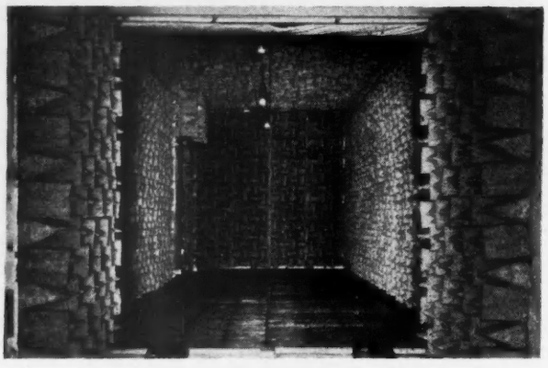
3 STEPS to less noise in Industry

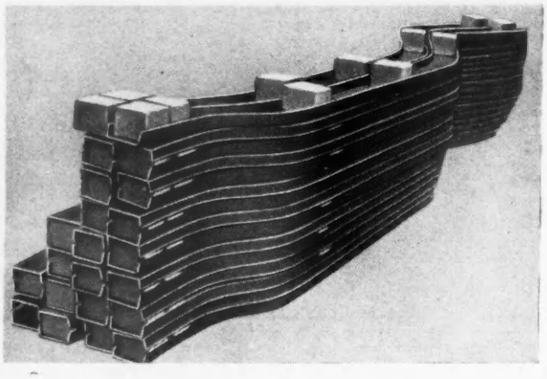
ABSORPTION

Echoes from walls and ceilings can easily double the noise level of a room. The cure is simple—a sound absorbing lining to walls and ceilings and if Stillite insulation is used for this purpose there will be a bonus of thermal insulation and fire proofing. Illustrated is an extreme example of this treatment, an echoless test chamber at the Motor Industry Research Association. The walls are surfaced with specially cut wedges of Stillite insulation.



DAMPING

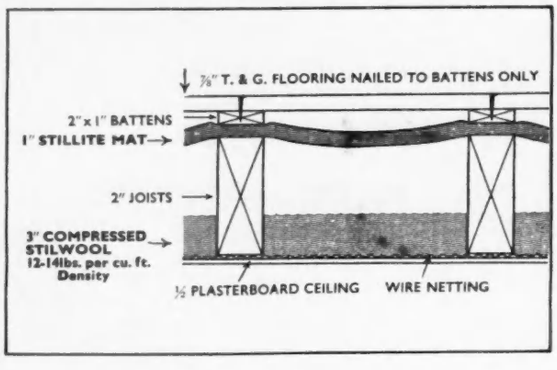
Sheet metal, whether in partitioning or machinery parts can easily amplify noise by picking up the vibration—by "drumming". Such metal fabrications can be treated by artificial loading. As an example, we illustrate the chassis assembly of Rover cars. Stillite sound damping blocks are sandwiched between the two halves of the main chassis members.



ISOLATION

Machinery vibration can be transmitted throughout the entire fabric of a building so long as there is a continuous structural connection with the machine's bed. The remedy here is to isolate the mounting of individual machines from the main floor or isolate the entire floor from the rest of the building. Here we have taken an example from the Building Industry in showing a diagram of a floating floor construction. Notice that even nails are not allowed to penetrate through the layer of insulation to establish a sound conducting contact with the joists below. The 3in. compressed Stilwool between the joists is to provide additional noise damping.

Clearly just one simple solution is not the answer to industrial noise but much can be done to improve working conditions and done quite easily by good design and a little "know-how". May we suggest a discussion of your particular problems with one of our Technical Representatives?



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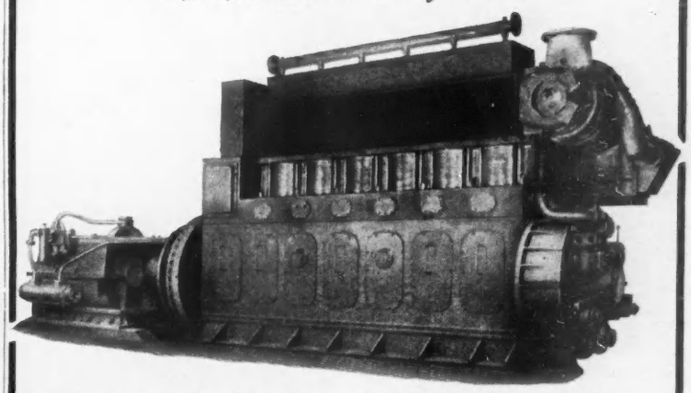

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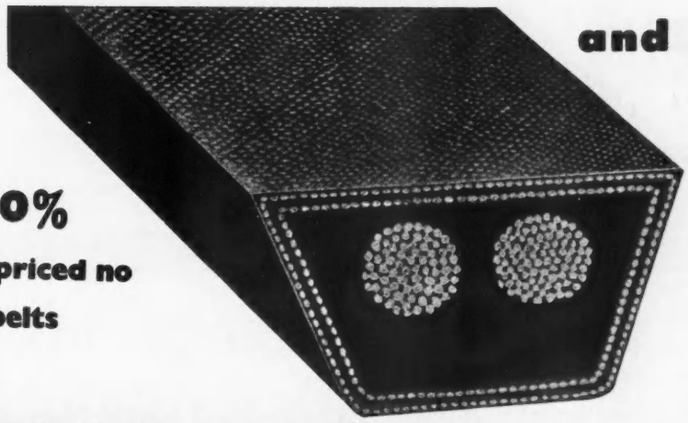

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International NU-SWIFT News

No. 3

HAVE YOU MET THESE PEOPLE?

HAVE YOU BEEN TO THESE PLACES?

47. In lovely GREENLAND, no longer merely the home of Eskimos and a colony but part of the Kingdom of Denmark, with output from cryolite mines becoming of increasing economic importance, trading posts of the ROYAL GREENLAND TRADING CORPORATION have been equipped with Nu-Swift.

48. The HOME OFFICE FORENSIC LABORATORY at PRESTON, LANCS., ENGLAND, famous for its fact-searching work in many murder trials, has been equipped with Nu-Swift.

49. Now also available with instructions in ARABIC, Nu-Swift extinguishers can be specified in this and any of 13 OTHER LANGUAGES at no extra charge.

50. PUNCH, the famous weekly, in recent years brightened by a face-lift, is now also, to prevent possible interruption in publication, protected by Nu-Swift. So are the giant presses in the three cities of publication of the DAILY EXPRESS, printed simultaneously every day in 4,000,000 copies, in LONDON, MANCHESTER and GLASGOW.

51. In GAUTEMALA, prosperous Central American State, all the BANKS, except one, are protected by reliable Nu-Swift.

52. In the unhappy event of another global war, many CIVIL DEFENCE EXPERTS believe that the self-contained Nu-Swift Universal (Royal Navy) 2-gallon Water/CO_2 extinguishers will be of great value in dealing with the many small fires likely to flare up at some distance from a THERMO-NULCEAR EXPLOSION at a time when public water supplies will probably be interrupted.

53. Where only a century ago, native warriors, with unexampled ferocity, fought the white man in ZULULAND, local farmers are now forming themselves into Nu-Swift fire fighting groups of five to pool their Nu-Swift fire posts and jointly combat attacks of the equally ferocious Fire Fiend. Twenty-nine such groups have so far been organised; they have proved themselves of great value in combating dangerous SUGAR CANE FIRES.

54. Through the failure of old soda acid extinguishers, CLOVER MEATS Ltd., WATERFORD, Republic of IRELAND, a firm which does a large export business, lost a contract worth £80,000. In consequence, 69 soda acid extinguishers were scrapped and instead reliable Nu-Swift were installed to the tune of £1,500.

55. The private railway coach of President KEKKONEN, the first citizen of democratic FINLAND, is now protected by effective, and reliable Nu-Swift Dry Powder Extinguisher, Model 1604.

56. 'Guinness is good for you,' says the famous slogan of the GUINNESS BREWERY, in Dublin, a national institution in the REPUBLIC OF IRELAND. It is now protected by Nu-Swift, and that, of course, is good for GUINNESS!

57. Founded in 1843, the NATIONAL METSOVIAN POLYTECHNIC SCHOOL in ATHENS, GREECE, the largest and most important scientific institution in South Eastern Europe and the Middle East has, after exhaustive investigation, decided to standardise on Nu-Swift extinguishers. Initial order was obtained in the teeth of keen, local, German, American and Italian competition.

58. To ensure rapid, reliable and efficient operation at sub-zero temperatures, THE PORT OF HELSINKI AUTHORITY, FINLAND, has installed Nu-Swift Dry Powder Extinguishers for the protection of all its buildings and cranes.

59. The works of GIESEN & WOLFF, LTD., NORTHAMPTON, ENGLAND, greeting card manufacturers, were recently destroyed in a 36-hour fire, fought by 80 firemen with the aid of 15 appliances. A second fire was caused in the roof of another factory nearby but was kept under control with extinguishers. Said Mr. Wood, the manager: "I would like to PRAISE THE NU-SWIFT SERVICING SCHEME. The extinguishers used by us were not of your make but your servicing kept them IN PERFECT ORDER—they saved our second factory. You can expect a large order when our new factory is built."

60. Challenged by WALTER LUMSDEN, an aerated water manufacturer of BROXBURN, NEAR EDINBURGH, regarding the reliability of Nu-Swift extinguishers, GEORGE S. RUDDOCH, a Nu-Swift salesman, was invited to discharge a Nu-Swift extinguisher, Model 1000, which had been supplied shortly before World War II. Complying with the owner's request, the salesman caused vapour to be shot out, as if the 20-YEAR OLD EXTINGUISHER had been charged only yesterday. Hitherto sceptical, the canny Scotsman at once placed an additional order.

61. Famous firm of mouse breeders, S. SCHOFIELD & CO., DELPH, LANCASHIRE, recently placed their first order for Nu-Swift Dry Powder extinguishers to protect their valuable breeding stock. Artificially bred mice are mainly required for medical research and for the testing and standardization of drugs. Stock is never below 200,000 mice, while annual output exceeds 400,000 mice.

62. ALY KHAN, son of the late famous head of the great Indian religious sect and prominent race horse owner, recently, for the protection of his famous and valuable STUD FARM in the REPUBLIC OF IRELAND, placed an order for Nu-Swift Universal (Royal Navy) Water/CO_2 extinguishers. The value of his breeding stock is enormous.

63. Preserved in PORTSMOUTH DOCKYARD, and annually visited by tens of thousands of sightseers, H.M.S. 'VICTORY' is today better protected against fire than it was during the Battle of TRAFALGAR when it served as Nelson's flagship. Worthy representative of 'The Wooden Walls of England' it is now, as is every ship on the active list of the Royal Navy, studded with Nu-Swift.

64. After demonstrations and competitive tests on the occasion of the recent visit to AUSTRALIA of Mr. W. E. CARROLL, Fire and Safety Authority from the Head Office of CALTEX OIL in New York, the world-famous Oil Company decided to standardise on Nu-Swift pressure-charge-operated Dry Powder Extinguishers for the protection of their establishments throughout the COMMONWEALTH OF AUSTRALIA.

65. Dynamite is used extensively in the SOUTH AFRICAN MINING INDUSTRY. By authority of the South African CHIEF INSPECTOR OF EXPLOSIVES Nu-Swift Dry Powder Extinguisher Model 1604 has now been approved for installation in vehicles carrying DYNAMITE.

DISASTROUS FIRES CRIPPLE INDUSTRY,

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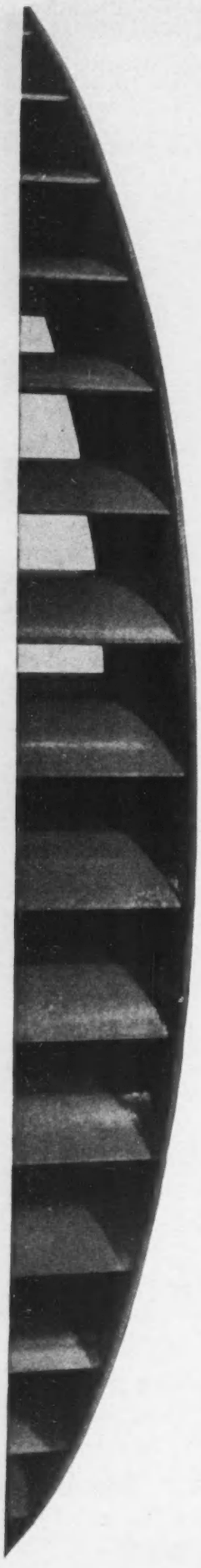
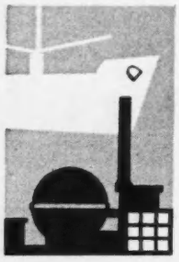
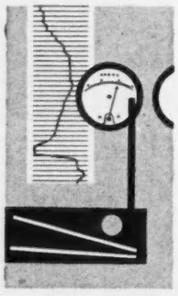


formula for leadership



Experience Founded originally in 1823 the Company has had the widest experience in the design and manufacture of all types of equipment for the handling of air and other gases. Blowers, exhausters, heaters, filters, dust and fume removal equipment, and of course, fans of all types, fall within this wide scope. Fans of every size and for every purpose, from Coal Mines to Aircraft Carriers, have been designed, manufactured and tested by Keith Blackman and installed in all parts of the world—experience unparalleled in the field.

Range The Keith Blackman range covers virtually every type of fan and blower in all sizes—axial types from 5 inch to 100 inch diameter, centrifugal types ranging from 1½ inch to 180 inch, and propeller fans from 6 inch to 72 inch diameter. Many are designed for special applications and in special materials including pvc. Other equipment is made for heating, cooling, washing, dust and fume extraction, filtration and air conditioning. *Five thousand fans of varying types are kept continuously in stock for quick delivery.*



Research Keith Blackman's lead in design is maintained by five separate research departments. Specialised facilities are available at Tottenham for the development and testing of axial fans, centrifugal fans and filtration equipment, while a metallurgical laboratory controls the quality of materials founded at Arbroath. Tottenham also possesses one of the most advanced acoustics laboratories in the world for the investigation of sound levels in all types of fan engineering equipment.
In addition, the company's generating station, as well as supplying power to the factory, is designed to produce a wide range of A.C. and D.C. supplies for the test beds.

Keith Blackman Ltd
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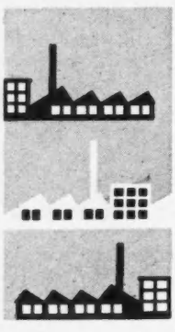
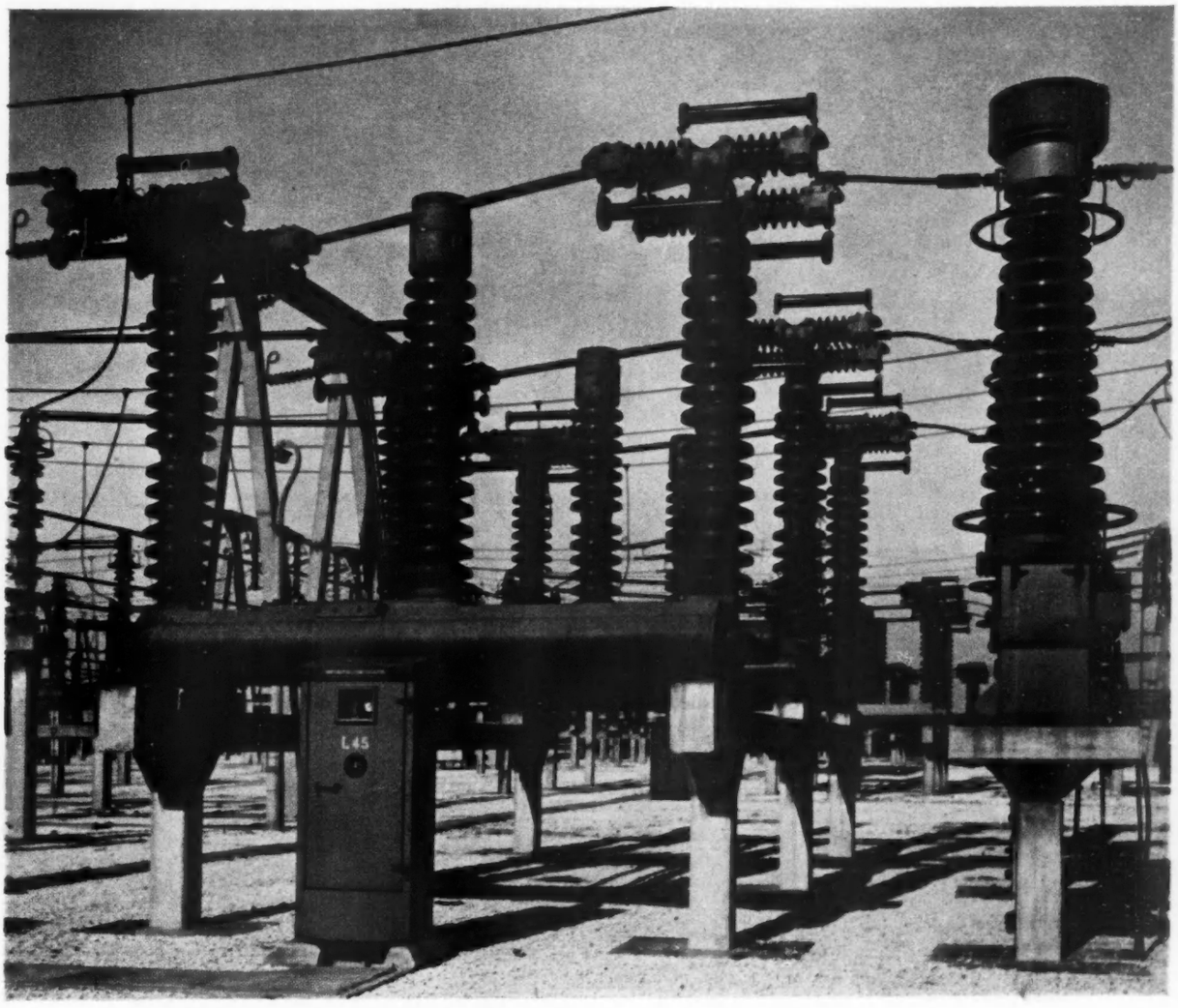
Leaders in the Fan Industry



Resources The company's three factories cover an area of 17¼ acres, and employ over 1,800 people. The main Tottenham works produces small and medium units and includes drawing offices, test facilities and machine shops, as well as the sales and administration offices. The Arbroath works deals with the production of the larger fans. Its iron and non-ferrous foundry plant supplies the whole of the company's casting needs. The Edmonton Factory concentrates on light sheet metal and plate work and the fabrication of steel structures. Virtually all components, including fan motors and bearing housings, are thus designed and manufactured within the organisation—a unique combination of resources.

Service Through the years the company has built up an enviable reputation for service at all stages.
Sales representatives are all fully trained technical men capable of giving 'on the spot' advice on routine applications or special problems. The sales organisation operates from branches throughout the country backed by a staff of qualified sales engineers at Head Office. Despatch of stock items, of which 5,000 units are kept continuously available, is possible in as little as four days. The Company has its own road transport fleet and direct rail connections from the main factory.

TA 2545/103P



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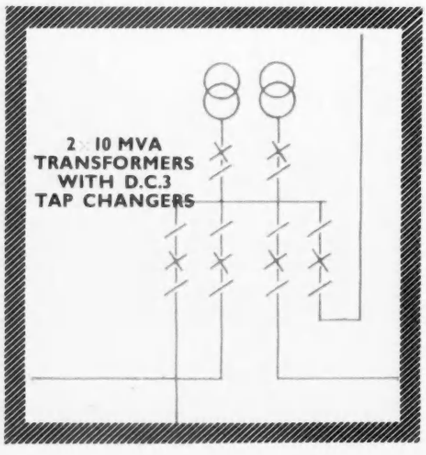

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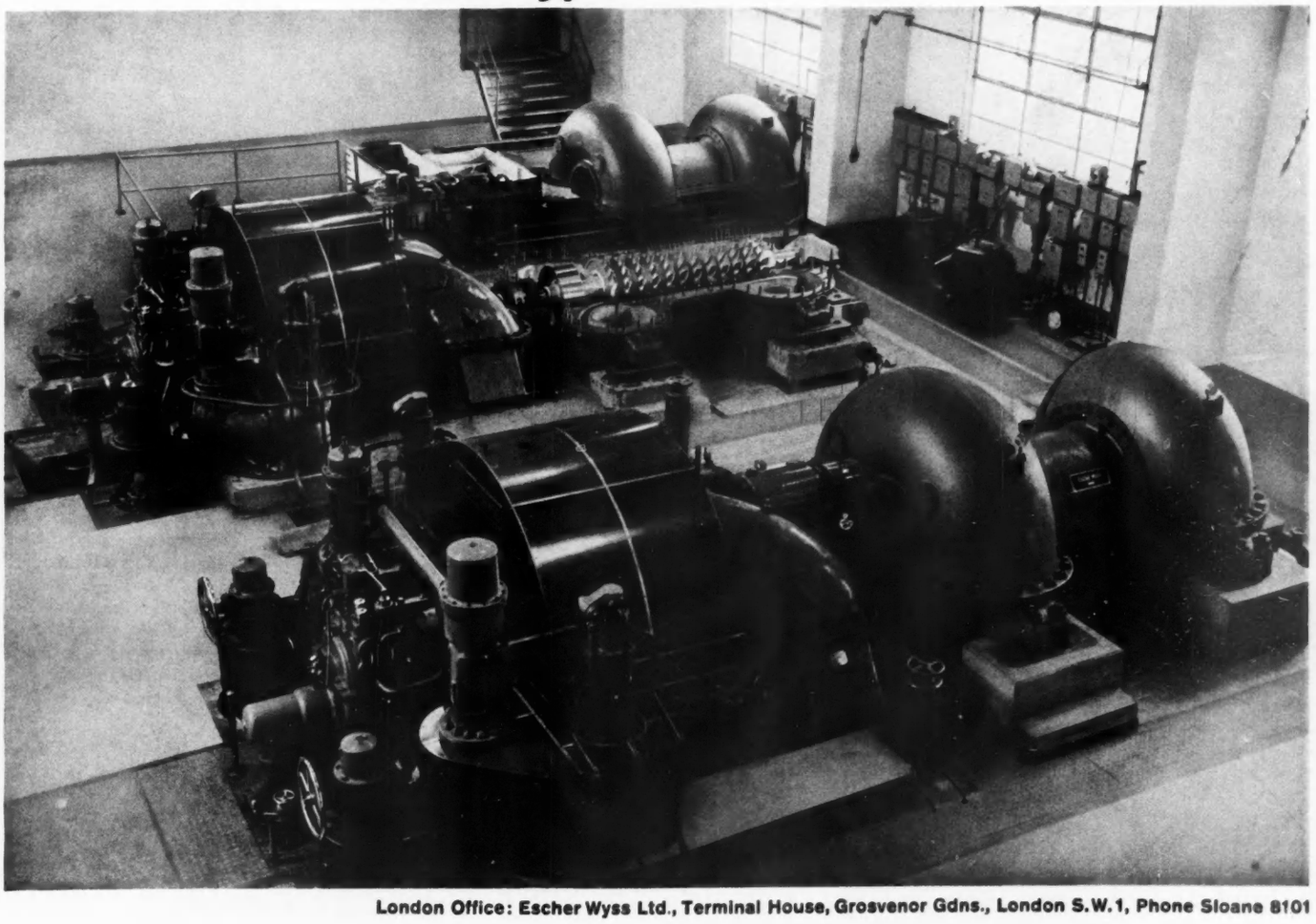

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Cement Plant

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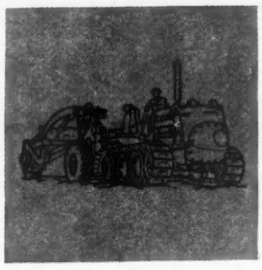

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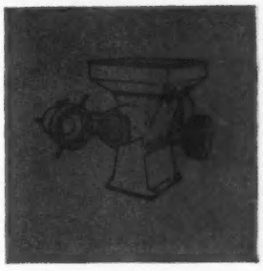
Eastwoods Ltd., Barrington Works.



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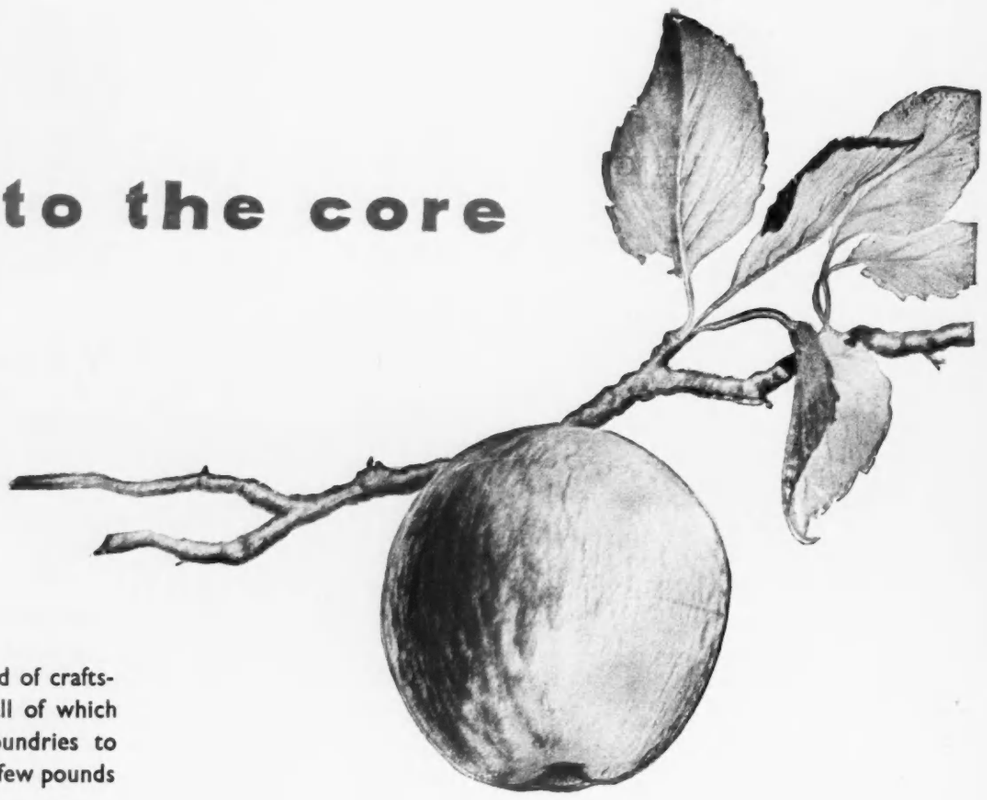
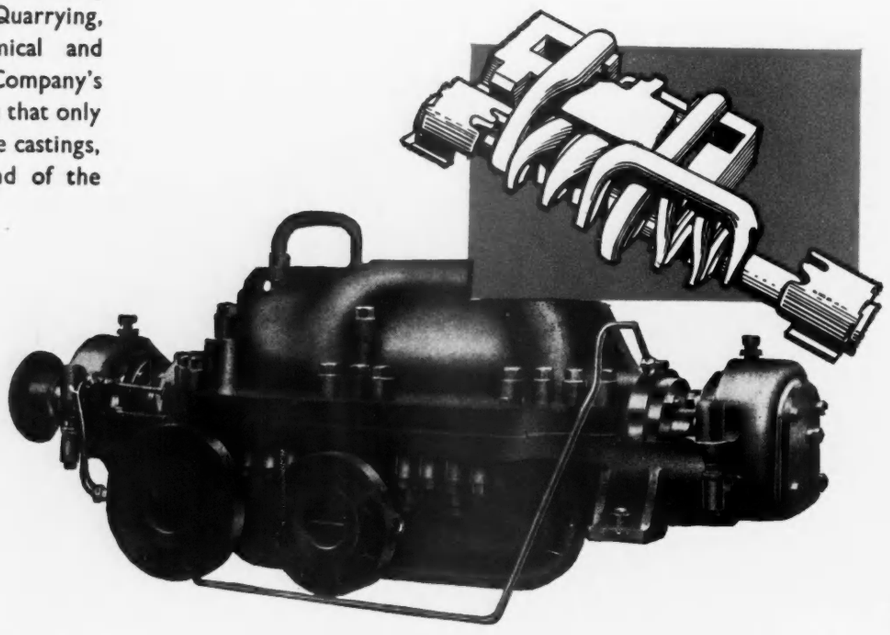
Sound to the core



Modern steel-founding is a blend of craftsmanship, art and technology, all of which are applied in the Osborn foundries to produce castings ranging from a few pounds to several tons in weight.

Castings in carbon and alloy steels are manufactured for many industries, including General Engineering, Mining, Quarrying, Oil Refining, Dredging, Chemical and Electrical Engineering. The Company's reputation as steelmakers ensures that only the finest steels are used for these castings, which are sound throughout and of the ultimate standard of quality.



Osborn castings are used in this *Hayward Tyler—Byron Jackson six-stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

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A Vulcan-Sinclair fluid coupling impeller, produced as a gravity die casting in Hiduminium 20 for the Fluidrive Engineering Co. Ltd.

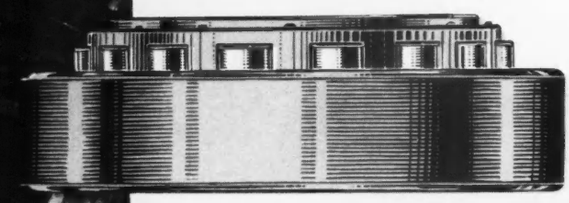
Hiduminium *Aluminium*

makes the most of

HIGH DUTY ALLOYS LTD., SLOUGH BUCKS.

right in the picture!

Bearings



* Napiers, in solving a problem in the gear-train of the Deltic engine, chose Hoffmann Bearings . . .
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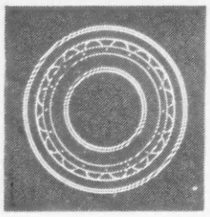

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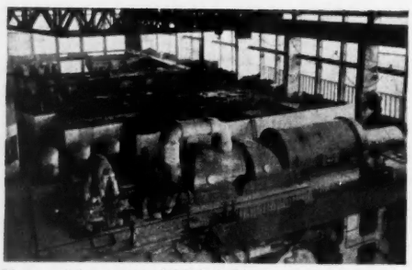

Photograph by courtesy of A.E.I. Turbine-Generator Division

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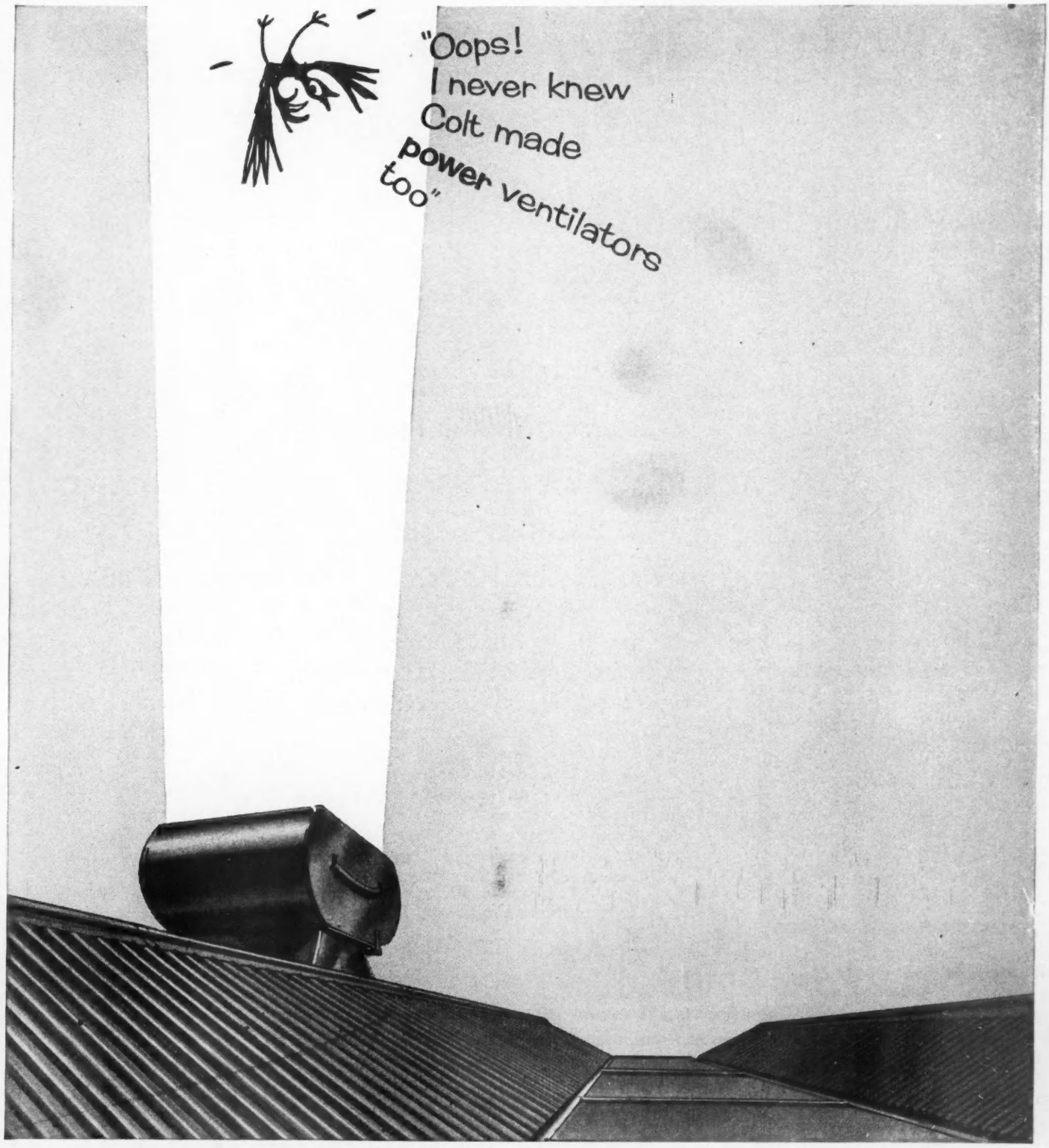

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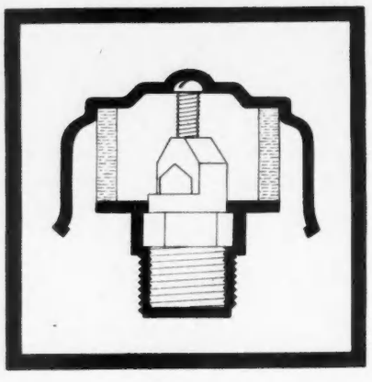

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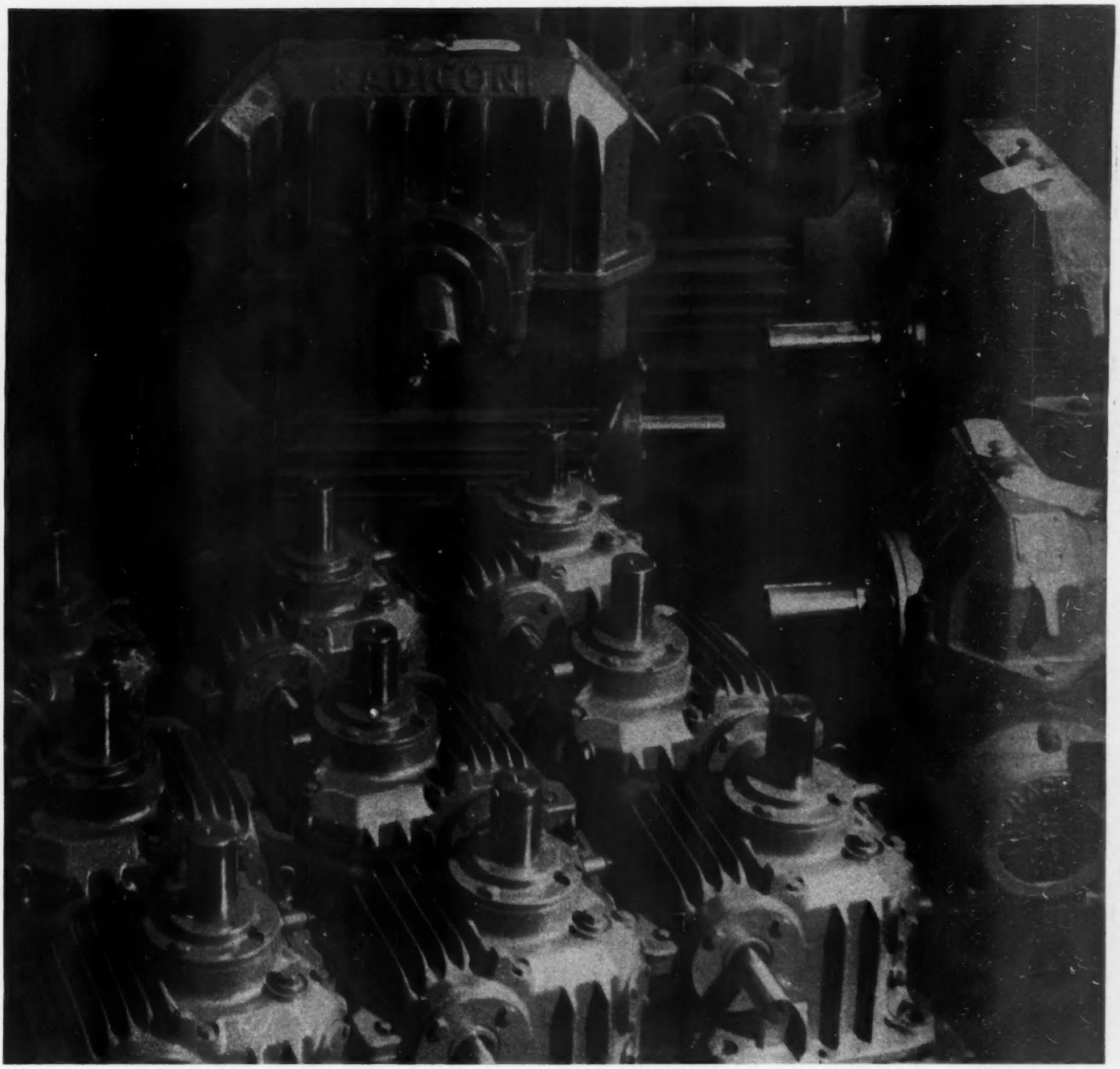

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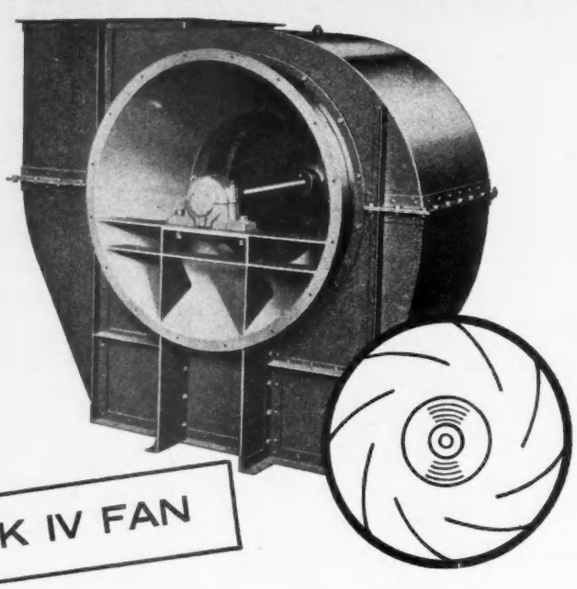

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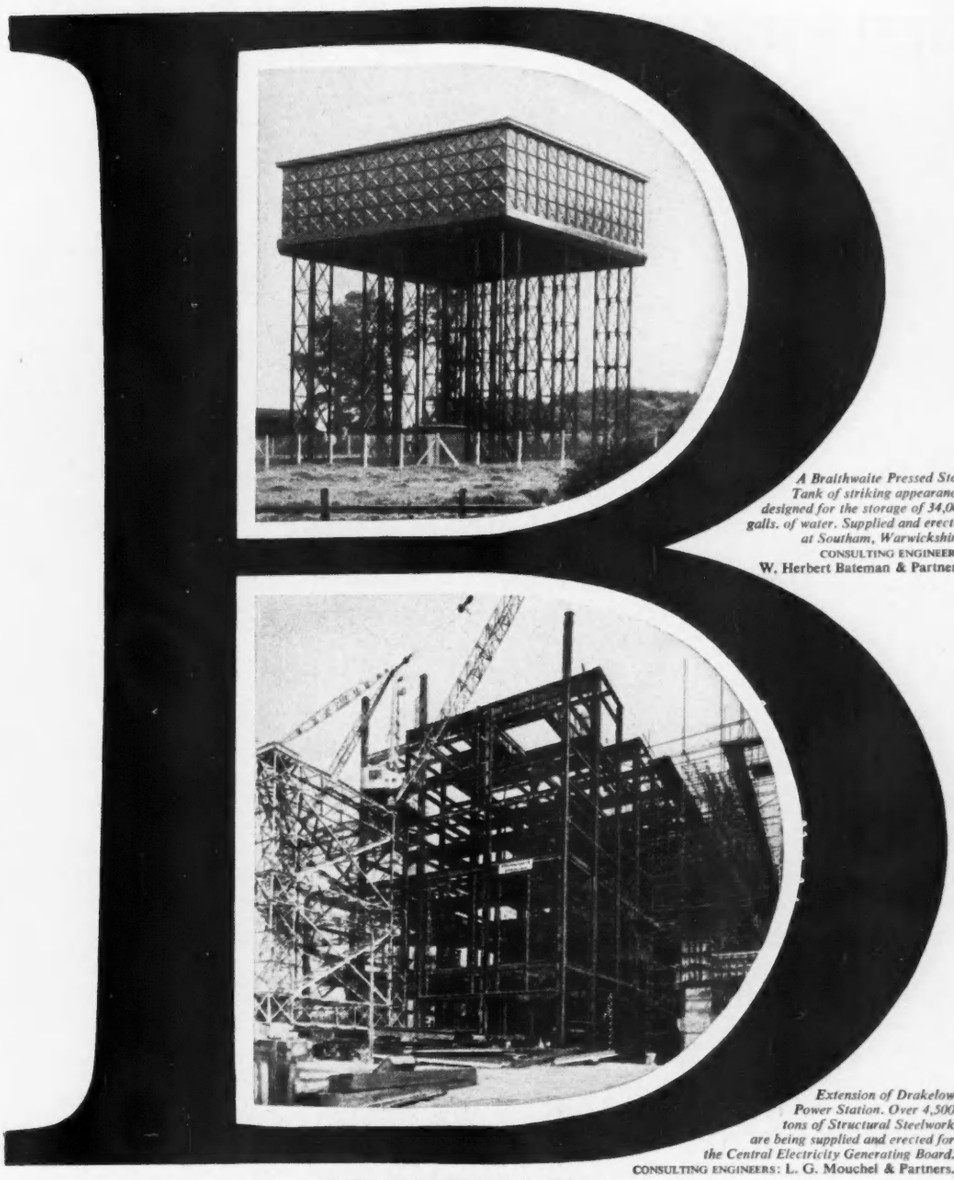

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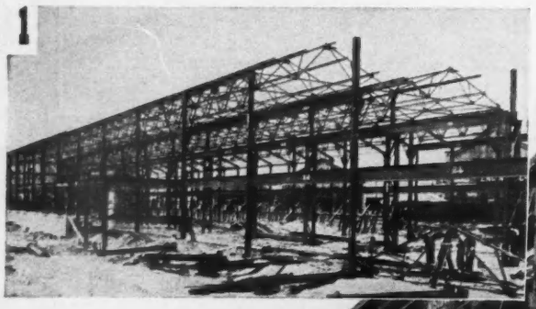

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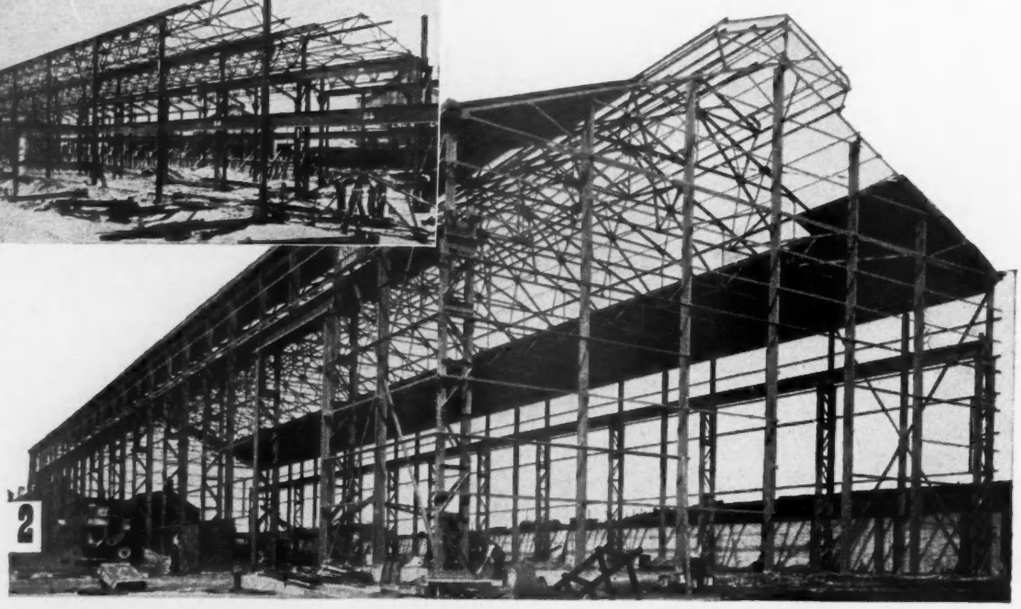

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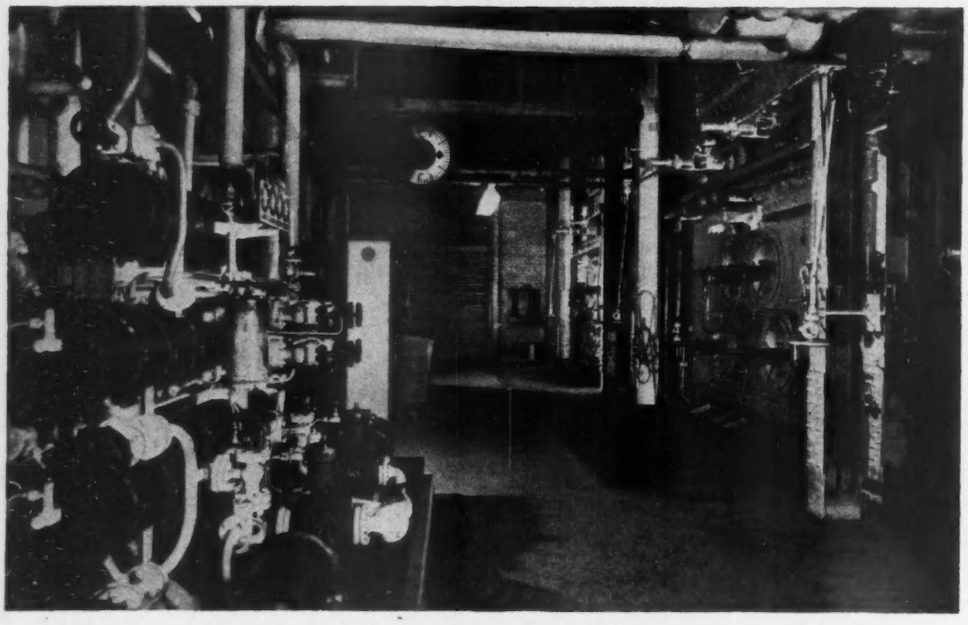

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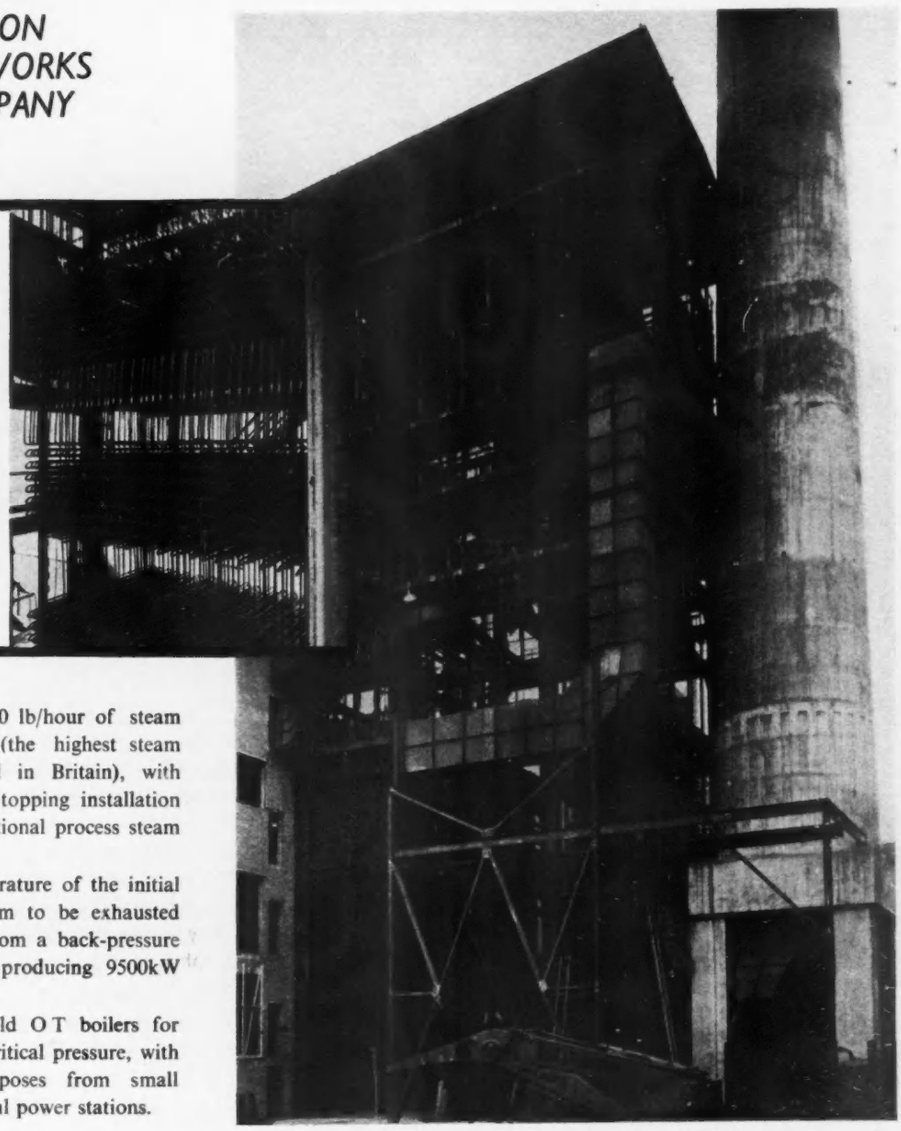

Main illustration. *A general view of the boiler under construction. This is an outside job, but the operating front is housed in the turbine building.*

Inset illustration. *This close-up of the top three banks of the evaporator, taken before the chamber walls were fitted, shows the type of evaporator surface.*

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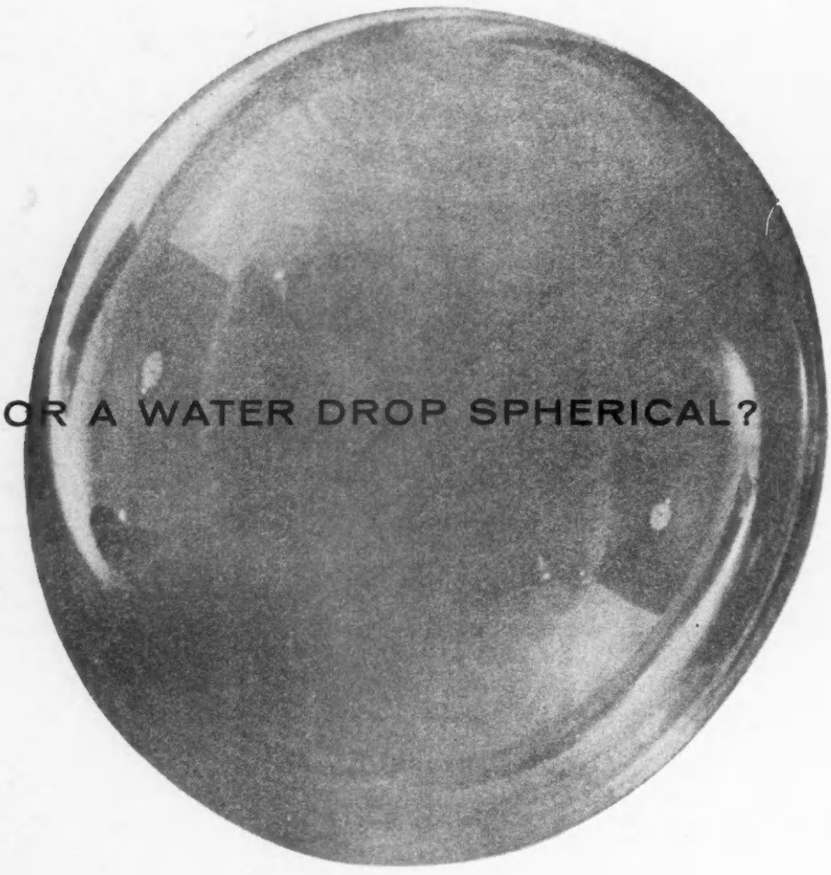

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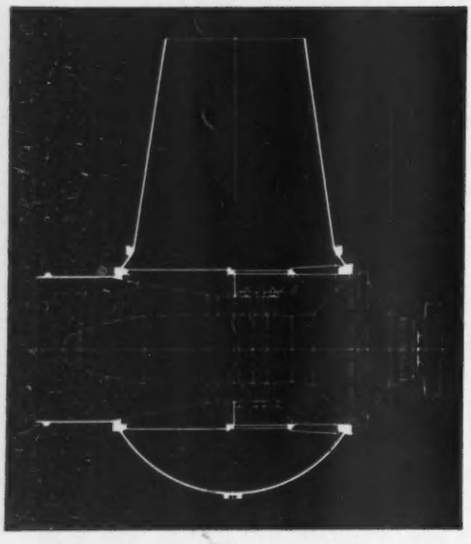

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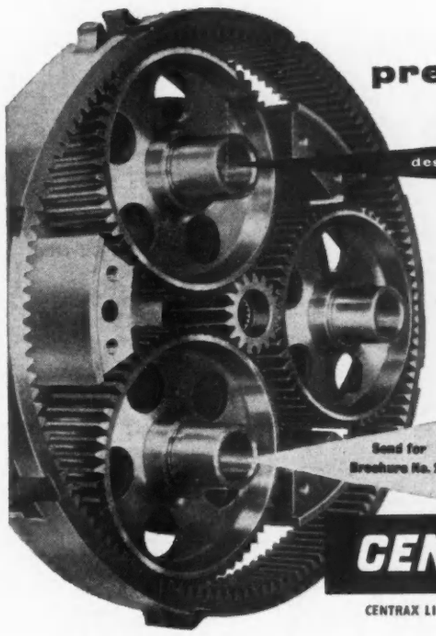

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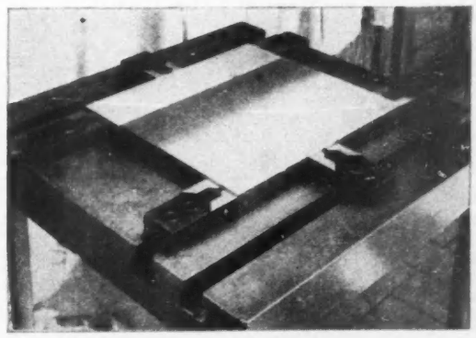

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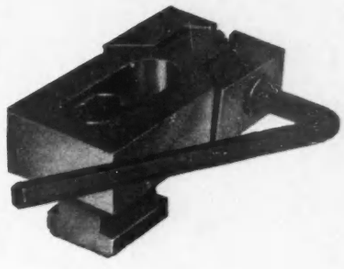

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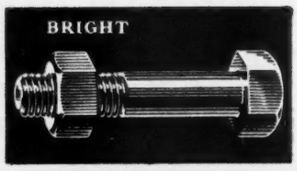

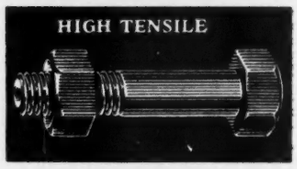

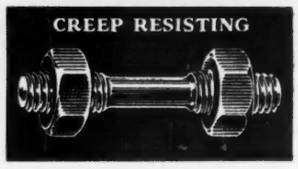

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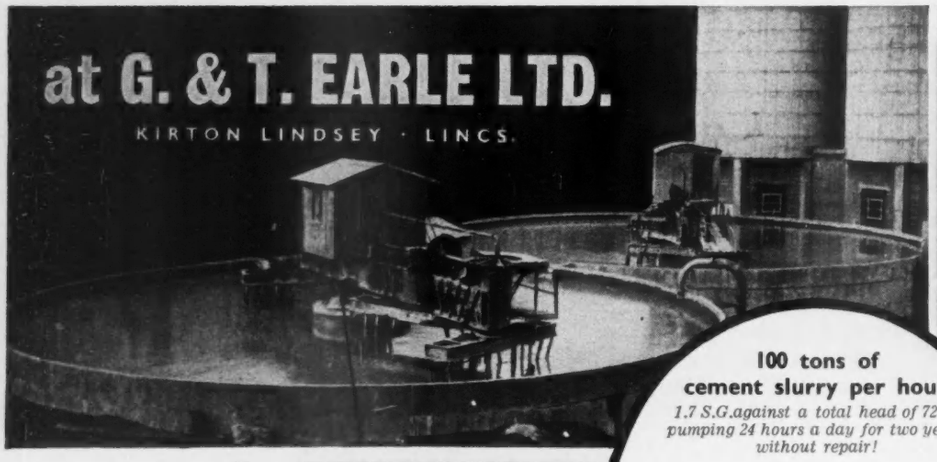

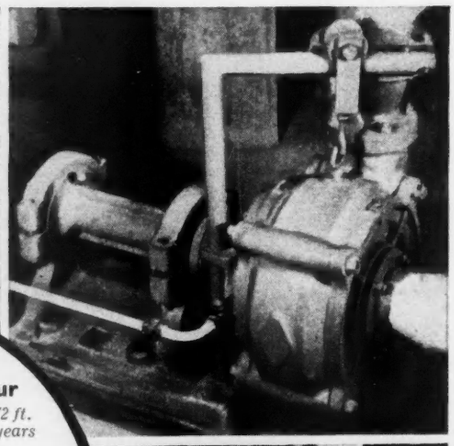

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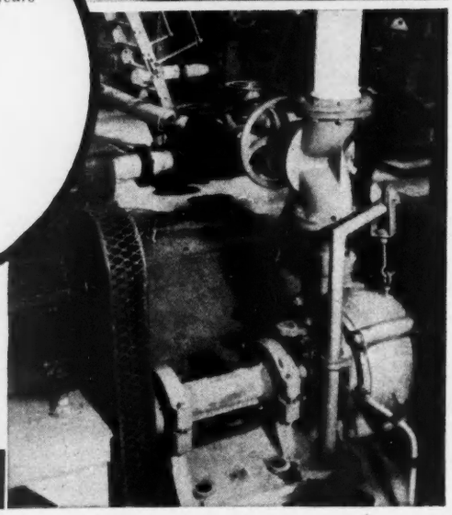

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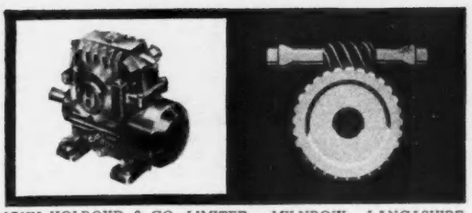

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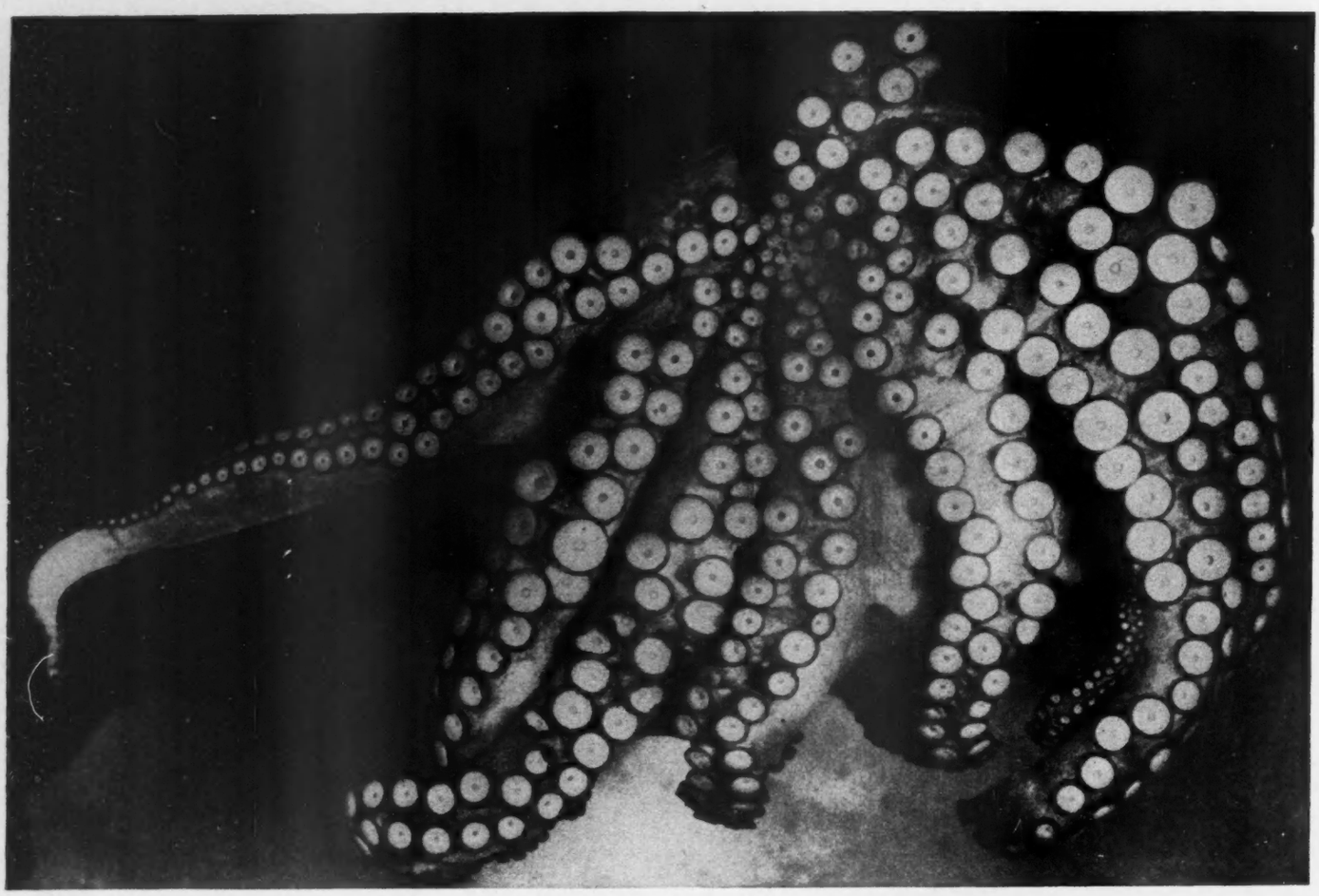

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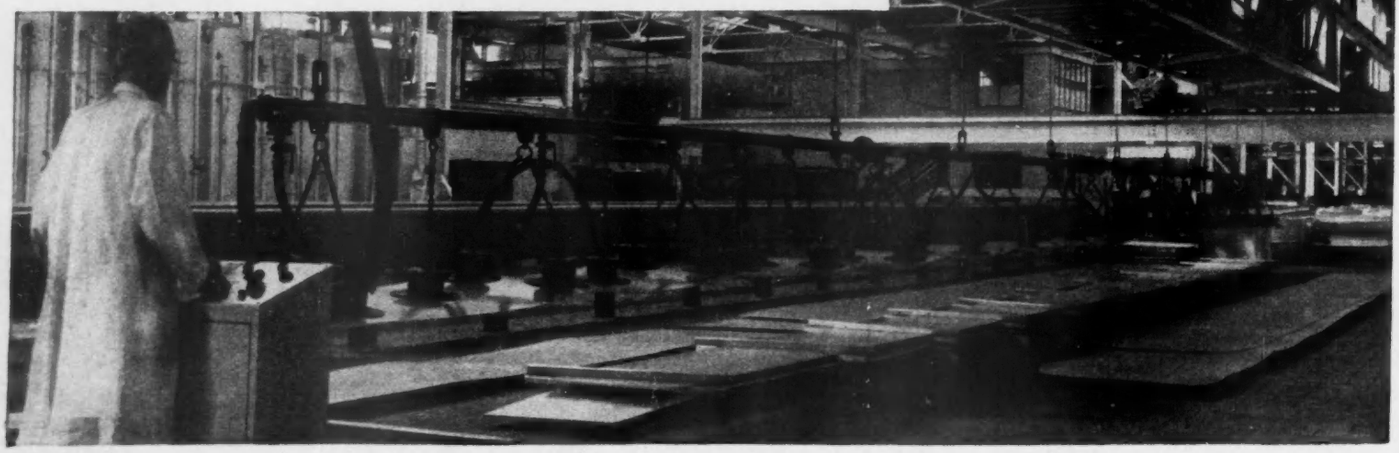

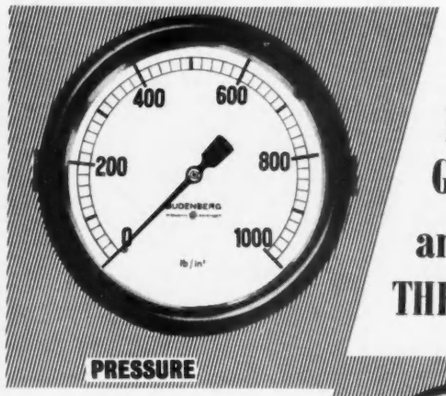

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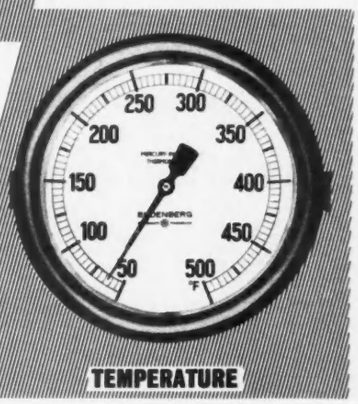

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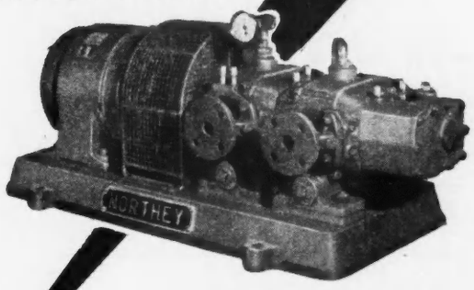

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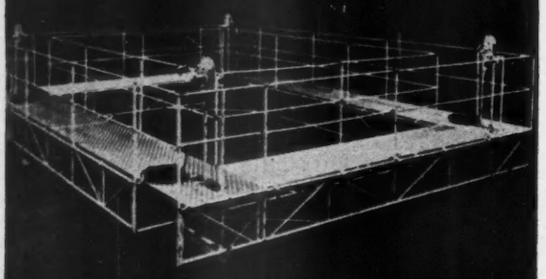
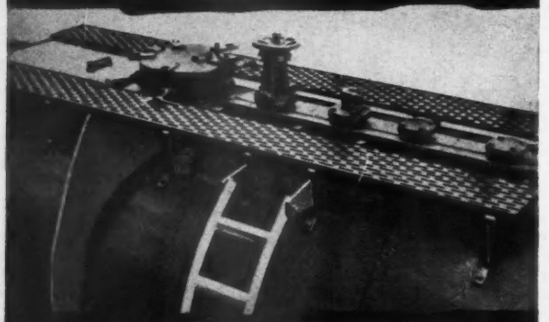
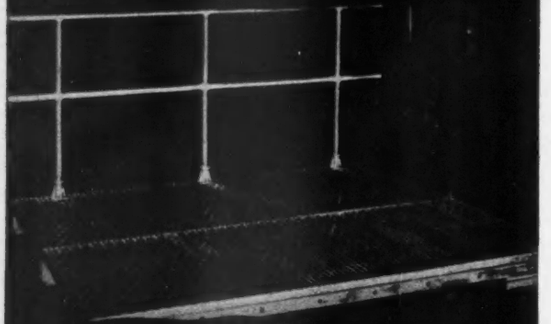


Alaflor suspended staging for inside boilers, as used by Sterling Safway Scaffolding, Jarrow.



Alaflor platforms supplied to Charles Roberts & Company Ltd., Wakefield, for Fisons Limited tank wagons.



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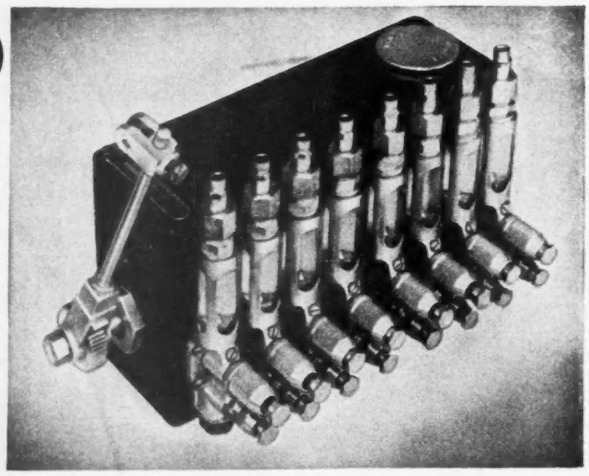

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ENGINEERING Impact

of Counter Attack By Coal

The decision of the National Coal Board to make solid fuel appliances and fittings—and the cost of installation and any consultant's fee—available on easy payments is not just a financial detail. It is a major marketing departure that may have lively repercussions for the manufacturers of the equipment, for the companies who do the fitting, and for domestic and industrial coal consumption.

Since the Coal Board is to run its scheme in consort with a finance company there may also be some political asides.

The importance of the departure is in its scope. The housewife, through her local dealer, will be able to fit the latest approved smokeless open grate, for upwards of £12, paying back the loan of anything below £50 in two years. And the satisfied customer may well come back again—for a central heating installation, without deposit, to be paid for over five years. The Coal Board's experts are certain that the fuel costs of solid fuel central heating are appreciably below those of oil—plus the important point that existing homes almost entirely already have coal storage facilities.

The small scale industrial or service company, particularly those with an ageing plant or a hopelessly costly array of electric fires, but with no great readiness to go to the bank for more on overdraft, is likely to be examining the exact saving between its present methods and the running costs of a modern solid fuel system, deciding whether it might not equal the repayments to the Coal Board.

The recent Political and Economic Planning report *The Market for Coal*, said that the running costs for coal would almost certainly be lower than for oil, and went on: " the coal industry would be wise to devote an exceptional amount of attention to the household market."

The Coal Board's efforts suggest that when it gives its mind to a problem the result can be revolutionary.

Voluntary Code for Outdoor Advertising

That there are not enough of the directional signs which make an ill-mannered mess of so many town centres and villages may be surprising. Mr. Henry Brooke has been told by some authorities that the rigid restrictions of the regulations on outdoor advertising have in some cases prevented necessary signs from going up.

He has now placed before Parliament simplified regulations and while some of the rigidity is intended to be reduced it is hoped that authorities will make orders taking more than the present 20 per cent of England and Wales under special protection.

These are matters where the countryside and areas particularly worth protection are concerned. A more urban problem is advertisement clutter. Unlit advertisements not more than 15 ft above the ground do not need local authority planning permission.

The advertising associations have been getting together on the clutter problem and this month their voluntary code is to be announced. It has been drawn up by the Outdoor Advertising Industry Advisory Council.

Since we seem irresistibly to be moving towards one great suburb from Liverpool to Dover, it is becoming important to make the garrulous and garish advertising assault in the streets conform to a pattern which is more or less pleasing. There are enough brains in the advertising profession to persuade the public and at the same time give them pleasure rather than a pain in the eye.

Sand, Dollars and Industry

Successive installations of pumps and pumping stations are adding to the capacity of the 412 mile Saharan oil pipeline to bring it up to the full annual capacity of 14 million tons by 1961.

For an investment equal to $105 million in this desert development the French franc area will eventually, it is expected, save between $200 and $250 million in foreign exchange each year. More important is the industrialisation and more efficient farming that will come to the Sahara and to Algeria and the oil revenues and taxes that further east have wrought so much change.

Much of the priming of this particular pump has come from the World Bank. A $50 million loan was made by the Bank to Société Petrolière de Gérance, the North African oil corporation owned jointly by the largest French oil company and by another company largely state controlled.

Estimates of the Hassi Messaoud oilfield, from which the oil is piped to Bougie on the Mediterranean, have placed the primary recoverable reserves at 170 million metric tons and the probable further reserve at 130 million. But a straight division of this total of 300 million tons by the annual pumping capacity of 14 million is hopelessly misleading as a guide to the life of the oilfield. Oilfield reserves have a characteristic of increasing almost as fast as the rate of extraction.

More Vacancies Fewer Idle

The latest figures showing the falling number of unemployed reflect in two important directions the rapid increase in industrial activity.

Not only was there a drop of 11,000 between 1 January and 15 February in the unemployed but there was a rise in the same period in the number of vacancies unfilled. On 10 February there were 257,000 jobs available, 12,000 more than in January.

The total of unemployed, 450,000, includes a large number of unskilled and of people who for various reasons make up the core of permanent " unemployables."

Among the 257,000 unfilled vacancies are many for skilled men but the areas with unemployment by no means overlap the districts suffering from a labour shortage. The two most difficult areas, Scotland and Northern Ireland, both suffered a small increase in the number not working. In Scotland the number rose by 2,652 and in Northern Ireland by 646.

The national average of unemployed, which was 2·8 per cent in February last year, has now fallen to 2·0 per cent.

of Reprieve for Flatford Mill

There are more reasons for rejoicing at the decision not to allow more water to be taken from the River Stour this summer than simply that the river at Flatford Mill will be preserved in its proper proportion and the trees not killed by encroaching salt water.

Lord Strang and now Lord Birkett, who for many years led the committee which fought for the setting up of National Parks, have been saying that it is high time those in authority respected the essential purpose of the parks.

In this the Government have a history of unwillingness to uphold the National Parks as unspoiled refuges of quiet countryside. Miserable milestones in the downward path include Trawsfynydd in one of the most remote corners of North Wales, and Fylingdales in a part of North Yorkshire, where increasing industrialisation over coming decades may make tremendous inroads into countryside lacking even the partial protection of National Park status.

But the Minister of Housing, Mr. Henry Brooke, has now told the South Essex Waterworks company that their application to take more water from the Stour cannot be allowed. Not only will Flatford Mill, the heart and centre of the paintings of Constable, go on looking much as it has done for centuries, but the farming and industrial interests to whom the present level of the Stour is important have won their case.

Mr. Brooke's decision is a choice against the easy way out. It shows that at least one man at Westminster practices beliefs in something more than the purely material. It is also a lively challenge to the engineers of the water company to solve their problem in a way which, if more difficult, will leave them with a better conscience.

They might remember the great words of George IV's charter for the Institution of Civil Engineers ". . . the profession of a civil engineer being the art of directing the great sources of power in nature for the use and convenience of man. . . ."

The " convenience " of Flatford Mill has been stoutly upheld.

West Europe's Biggest Dam

The idea that Europe has its own under-developed areas is one that is often overlooked. These include not only the Italian South, the Mezzogiorno, but considerable areas in south east and central France. The work of bringing life to these regions usually begins with barrage schemes which not only regulate the supply of water to the land but generate electricity. The tragic failure of the Malpasset dam drew attention to one of these schemes. Another dam, in fact the biggest in Western Europe, is now being brought into use at Serre-Ponçon on the River Durance south of Grenoble. This river, which varies from a raging torrent in winter to a dried up bed in summer, is famous for its inconsistency. Now it is going to be brought under control and put to work. For four years some 2,000 workers have been busy moving some 18 million cubic yards of earth to form a great reservoir over twelve miles long. It is estimated that the amount of earth moved is equal to the size of the Great Pyramid. The cost of this undertaking so far as construction is concerned has been about £330 million. On top of this, the 1,200 inhabitants of two villages that had to be submerged were paid some £4 million between them. The hydro-electric plant at the dam will produce 880 million kWh of electricity a year.

The idea for a dam on the River Durance was first mooted in 1856. The plans for the present work were drawn up between 1946 and 1950, and building began in 1955. Unlike the Malpasset dam, the Serre-Ponçon dam is built of earth. A large mud deposit made it impossible to choose a design using concrete. The dam itself will be 711 yards wide and 137 yards high.

Putting a big new stretch of water down in the landscape has affected other things besides the erratic River Durance. Twenty-five miles of new roads had to be built and ten miles of railways have been re-routed. Now the work is complete and the reservoir is being slowly filled up. In the years ahead a thousand square miles in this part of south east France which has hitherto been dry will be irrigated and supplied with electricity.

and Planning Against Fires

The first National Fire Protection conference that met in London last Thursday and Friday could hardly have chosen a more disastrous year to have followed.

The fire loss for 1959 is estimated at £44,179,000 and of this £8,700,000 was lost in three fires alone.

The damage inflicted on industry by fires is not confined to material losses and personal injury, the number of industrial fire deaths last year was 25. In factories where complex assembly lines are carrying cars and other products, or where costly machinery is being constructed, a relatively small fire can be the cause of a serious and financially highly unpleasant breakdown in production.

The car industry, with its high labour costs and the general need to keep a mass of capital investment running at full speed, is especially sensitive to quite small delays. Mr. T. P. Williams, plant and facilities manager of Vauxhall Motors, the Luton General Motors car plant, revealed to the conference the great care and detail of the General Motors building code which had been completely overhauled after the major fire of 1953 at their Livonia (USA) works.

From the consultant and all the other engineers in on the first planning of a factory, the construction and lay-out, the placing of fire walls and the style of roof chosen, right through to the heat-treatment of metals, the smoke and heat release preparations, and the vehicle trimming and painting arrangements, the work of many of the engineers in the plant has an influence on fire risk.

Materials Challenge of Skydrol Fluids

A fire resistant hydraulic fluid known as Skydrol 500A is now standard for high flying aircraft, but materials for seals and other materials have had to be developed to contain it satisfactorily.

By J. F. Churchill, B.A. (Cantab)

Monsanto Chemicals Limited

Fire resistant hydraulic fluid will be used in the Vanguard aircraft for delivery to Trans-Canada Air Lines later this month.

Skydrol is the name of non-inflammable hydraulic fluids introduced to the aviation industry by Monsanto Chemicals Limited. The need for such fluids became intense as hydraulic pressures rose to 3,000 lb per sq. in in such aircraft as the DC-6. But now these pressures are commonplace. Before the advent of skydrol, fires arising from failure of hydraulic connections during emergency take-off stops, when hydraulic fluid would be forced on to red hot brake drums, had become more than a distant possibility.

The first fluid, Skydrol 7000, was introduced about 10 years ago in collaboration with Douglas Aircraft Company. With the arrival of high flying turbo-jet and turbo-prop aircraft, encountering outside temperatures as low as −110° F, a new fluid was needed. Skydrol 500A was thus introduced (the suffixes referring to the kinematic viscosities of the fluids at −40° F).

Skydrols are phosphate ester based materials. Unfortunately for the aviation industry they create material problems; they swell most rubbers, plasticise various thermoplastics and remove a number of paint systems.

Skydrol-resistant seals, essential for a reliable hydraulic system, are made from butyl rubber, but even this material initially had one or two disadvantages. It is fairly soft, and it does not have as good a temperature range as some other rubbers. It was also difficult to produce with good compression set properties. However, in recent years much progress has been made in compounding of butyl rubbers.

For example, butyl rubbers used in the early DC-6 aircraft had a compression set of approximately 20 per cent, this being a measure of their ability to recover instantly after prolonged deformation. Those available today show a corresponding figure of 5 per cent. In addition, some of the latest resin cured butyl rubbers have better performance in Skydrol 500A fluid at elevated temperatures. In the past butyl seals that were serviceable at 70° C might suddenly become useless at 90° C, but the resin cured materials are much more reliable in this respect.

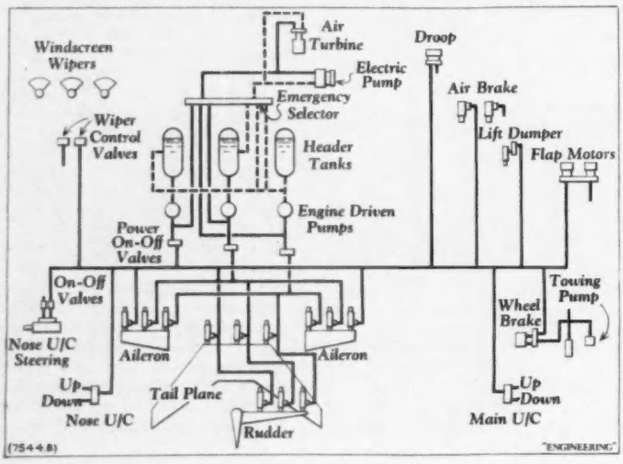
Some concern has been expressed at the effect of these fluids on natural rubber aircraft tyres, as Skydrol is known to swell natural rubber. Experience has shown that Skydrol fluids are no worse in this respect than petroleum fuels, solvent cleaners, or synthetic turbine oils, and these liquids are just as likely to come into contact with the tyres as hydraulic fluid.

Perhaps one of the most important maintenance procedures for an airline operating both Skydrol and mineral oil aircraft, is to ensure that only Skydrol components and seals are used to service the aircraft with Skydrol hydraulic systems, and only mineral oil seals and components are used in mineral oil aircraft. If a reasonable percentage of mineral oil was added to a Skydrol system, it would ultimately have a bad effect on the seals, and *vice versa*. If neoprene seals were by mistake fitted to a Skydrol system, they would become useless in a matter of days.

Skydrol fluids have demanded new paint systems. Phosphate esters rank as excellent plasticisers, and the only paints that will resist Skydrols are epoxy resin based compounds which must be carefully cured to be effective. For full adhesion it is important to chemically clean the metal surface, and treatment may consist of up to five steps before the surface is ready to receive the primer. Of course, Skydrol resistance is only one of the properties required of a paint, as the coating must also be extremely resistant to moisture and salt sprays.

Improving the Skydrol resistance of a paint by change in formulation or curing may cause a deterioration in moisture resistance. Thus, paint development has often been a matter of compromise between Skydrol resistance and moisture resistance, with various other properties needing to be considered.

The American aircraft industry places much emphasis on the protection a paint will give to contacts between dissimilar metals, but this property is not considered so important in the British aircraft industry, where the placing of dissimilar metals in direct contact on an aircraft frame is discouraged. This practice helps to prevent the effects of electrolytic corrosion.



Aircraft which use or will use Skydrol 500A

- Boeing 707 and successors
- Douglas DC-8
- Convair 880 and successors
- Vickers Vanguards
- Vickers VC-10 and successors
- De Havilland DH-121
- Caravelle Mark II

Single hydraulic system of the DH-121 (see left) will use Skydrol 500A fluid.

In a modern transport aircraft a great many plastics are used, and where there is possibility of Skydrol contamination, they must be selected carefully. Thermosetting materials are generally compatible with Skydrol fluids, but they must be properly cured to be fully compatible. Among the thermoplastic materials that can be softened by Skydrol fluids are vinyl compositions, nitrocellulose lacquers, oil based paints, linoleum, asphalt, synthetic resin adhesives and certain potting compounds for electrical components. Softening does not, however, occur after momentary exposure, and spills that are wiped up with soap and water do not harm the plastic materials.

Before these fluids were used in aircraft hydraulic systems, the normal material for jacketing the electric cable, used throughout the electrical installation of the aircraft, was pvc. However, this cannot be used in a Skydrol area, and aircraft manufacturers have thus gone over to nylon. Nylon has since proved better than pvc in several other respects: it has superior abrasion resistance, and does not become brittle on ageing. The practice of marking each cable by slipping a small preprinted pvc collar over the ends of each cable as an identification tag has been replaced by preprinting the entire length of each nylon cable with a serial number, repeated every few inches.

Skydrol 500A is compatible with the normal metals of construction used in aircraft except pure copper at elevated temperatures. It is well known that copper will slowly catalyse the gradual decomposition or hydrolysis of many organic esters, and the phosphate ester base of the fluid is no exception.

The addition of a few per cent of other metals to the copper will greatly reduce the catalytic effect on the fluid, and in various applications beryllium copper and phosphor bronze alloys are used, as well as normal bronze materials. However, high pressure piping in aircraft is now usually made from stainless steel, and many of the low pressure return lines are made from aluminium alloys. These materials are both completely compatible with Skydrol fluids.

The rise in neutralisation number of test samples of Skydrol 500A when in contact with various metals at high temperatures, particularly in the presence of moisture, has been studied, and the conclusion is that, provided hydraulic system temperatures are kept down to a reasonable limit, these elevated neutralisation numbers will not be found in service. This has been satisfactorily demonstrated by the experience of Boeing 707 operators, and is confirmed by test data accumulated on the first DC-8's and two DC-7C's that have flown some 6,000 hours on Skydrol 500A.

The adoption of Skydrol fluids has caused aircraft manufacturers some troubles, but most of them have by now been satisfactorily overcome and, quite simply, aircraft equipped with these fluids are safer from fire hazards than aircraft which are not. The happy record of aircraft equipped with these fluids is that they have never had a hydraulic oil fire in over nine years of operation and 16 million flight hours.

Improved 300° C Rubber —Use for Fire Walls

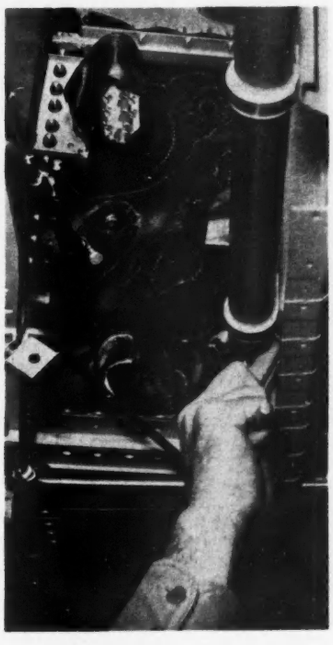
The useful life of Viton fluorinated rubber has been increased to double in an improved version introduced by Du Pont in the United Kingdom. When oven-aged in air at 200° C or less, vulcanisates now remain fully elastic for indefinite periods. At higher temperatures they can be expected to remain elastic for more than 1,000 hours at 250° C and 60 hours at 300° C.

Resistance of the new rubber, especially to diester lubricants and hydraulic fluids used in aircraft, is improved, and useful life is prolonged in presence of such chemicals as red fuming nitric acid and glacial acetic acid.

Properties of Viton Rubber

Hardness	60-95 durometer on Shore A
Tensile strength:	
Room temperature	2,000-3,000 lb per sq. in
150° C	300-1,000 lb per sq. in
Tensile elongation:	
Room temperature	100-400 per cent
150° C	80-200 per cent
Compression set	set 3-10 per cent after compressed 25 per cent at 120° C for 70 hr
Brittle point	− 45° C
Low temperature modulus	10,000 lb per sq. in. at − 30° C
Ozone resistance	no cracking after 28 days in 100 p.p.m. ozone
D.c. resistivity	$1{\cdot}4 \times 10^{16}$ ohm-cm
Power factor	0·025
Dielectric strength	412 volt per mil

Since their commercial introduction in 1958 they have been widely adopted for aircraft parts and in a variety of applications in cars, oil well equipment, chemical processing equipment and household appliances. Among their uses in aircraft is that of flexible fire walls which are now said to offer better heat and flame resistance than stainless steel. The new wall seals are made by coating asbestos fabric with Viton, which has



Fire wall in the Convair B-58 is a Viton covered asbestos fabric.

replaced similar neoprene covered seals; added reinforcement is given by Inconel Ni-chromium alloy wire.

Such fire walls are being used in the Convair B-58 bomber. One of the problems which the designers of this aircraft faced was choice of flexible material offering resistance to flames and ambient temperatures of 250° C. The swept back wing of the aircraft containing thousands of gallons of highly flammable fuel is separated by an equipment tunnel housing the hydraulic lines, electrical equipment, fuel lines leading to the four jet engines, and the air-conditioning ducts and equipment.

The fire seals were developed by Raybestos-Manhattan and Convair. During this period the fabric showed that it would withstand a direct flame at 980° C from a gun-type oil burner for 60 minutes. Moreover, in comparison with other elastomeric materials it did not emit smoke or glow on the opposite side from the flame. When laminated with asbestos, the total thickness was 0·04 in which weighed about 3 lb a sq. yd and had a minimum tensile strength of 200 lb per in width.

Du Pont Company (United Kingdom) Limited, 76 Jermyn Street, London, SW1.

Anodic Control of Chemical Corrosion

The system of controlling corrosion of metals immersed in conducting liquids by impressed current, known as *cathodic* control, has been practised for many years, and there are now firms who specialise in application of the method. Not to be confused with this is another process of control in which the metal to be protected is made *anodic*. Once again the principles have been recognised for several years but it is only recently that it has been applied on a full-scale plant.

In America the anodic process has been christened Anotrol, and Continental Oil Company, of Baltimore, have successfully applied it to preventing attack of 304 stainless steel by 67 per cent sulphuric and sulphonic acids. The process depends on stabilising the oxide layer (which can form on many metals when dipped in aqueous solutions if they have the right potential in the solution and if the oxide is not attacked by it). The metal is made anodic by impressing a voltage on it relative to a cathode made of, say, platinum which is immersed in the liquid. The success of such passivation depends on fine control of the voltage for the protective anodic films are unstable outside small limits.

Edeleanu demonstrated the process on a stainless steel pilot plant holding strong sulphuric acid at a conversazione run by the Corrosion Group of the Society of Chemical Industry in 1957. Shortly afterwards ICI demonstrated that titanium was the ideal metal to which the process could be applied. The process for the two metals is basically the same, but there are major differences in the scope of the process and in the ease with which the method is applied. Thus for stainless steel the range of acids is restricted, for example, it could not be protected against corrosion in hydrochloric acid whereas titanium can, while even in sulphuric acid, the potential (voltage) range for stainless steel is quite narrow.

The experience of Continental Oil is that passivation of stainless steel in the liquids previously mentioned required accurate maintenance of impressed voltages within the order of 0·05 volt; this is difficult. For titanium exposed to sulphuric acid, the voltage range for passivation is much larger, probably of the order of 80 volts, and this presents no difficulties. Success of the American installation can be gauged from the fact that the incidence of pitting, which called for tank repairs about seven times a month, has been so reduced that no tank repairs have been made in a year's operation. Iron pickup by the chemicals has been reduced ten times.

There are, however, limitations on use of the process whatever development work is performed. First the solution must be a good conductor and the metal/liquid system must be suitable for anodic passivation. Halogens cannot be handled except in small concentrations, nor can reducing environments. Then, copper base metals cannot be protected by this system. Arising from the first of these limitations, metal immediately above the liquid level which is wetted by condendate is not completely protected because there is a restricted path for ionic flow.

There still remains the possibility of stress cracking in steels which are highly stressed, and this will require sorting out. In conditions where the process can be used it looks promising: current densities, once the film is established, are low, of the order of 0·005 amp per sq. ft; and the throwing power is good. As an example of the latter, a system of 60 ft length of ¾ in stainless steel tube with 15 bends was protected by a single cathode located at one end.

Plastic Mouldings for Cars

High density polyethylene is saving 2·8 lb weight in the 1960 models of the Ford Motor Company in the USA. This first major use of thermoplastic materials in car interiors is not only a logical advance in simplifying production, but also offers a financial saving: the cost is down 30 per cent on that of the standard painted steel stampings. In the whole automobile industry Ford report that an estimated $3 million were saved last year by use of plastics.

The front seat side shields were made in plastic primarily because of the advantages in styling which could be obtained with the process of injection moulding at little extra expense compared with multiple metal stamping operations.

Side shields for these seats are injection moulded in high density polyethylene.

Use of plastics in cars is gaining momentum on both sides of the Atlantic as the confidence of fabricator and consumer is being won. It is not only prejudice against new materials which has held up their exploitation. A great deal of work has had to be performed to prevent attack of plastics by ultraviolet light and by the elements. That these have been satisfactorily solved for polyesters is shown by the car manufacturers who are now prepared to associate their names with the materials (quite apart from considerations of cost). The outstanding example is that of Daimler, whose SP250 has a glass reinforced polyester body.

Pvc fabrics are widely used for upholstery, and the Routemaster bus is just one example where the plastic has been used for internal window surrounds. Interest in a new range of acetal plastics such as the one made by Du Pont under the name of Delrin has not yet extended to their use in cars. It is rumoured at the SAE, however, that instrument cluster housings will be injection moulded in the material for 1962 American models. Certainly Du Pont have made such clusters in a zinc die casting mould and have illustrated that satisfactory mouldings can be made with a weight reduction of four-fifths; self-tapping screws can be used and will not cause stripping, while the colour can be moulded into a surface which requires little, if any, mechanical finishing.

Plain Words

By Capricorn

What a mess we make of moving with the times. We either dig our heels in to stop what we conceive to be the rot, or frantically pursue the younger set and make ourselves ridiculous succumbing to the fatal misconception that age has nothing of its own to offer and hence must ape the essence of the young. Though tiresome in their way, I prefer the heel-diggers.

As we grow older we feel an increasing affection for the things we know and have known. Our sense of achievement in solving the problems of our day makes our own solutions dear to us. How must the man who so ingeniously devised the tramway braking system have regretted, even resisted, the departure of the tram? But, however apt they may have been, our solutions mean nothing if the problems themselves exist no longer. Even the best ideas can be overtaken by events. "Why can't people keep their minds open?" a young man said to me last week. "Age is no excuse for being unreceptive to new ideas."

I agreed, but with reservations. Whatever we do to prepare ourselves for change, new kinds of change will catch us by surprise. Determined though we may be to evolve with the times, we shall be defeated by the fresh concepts of evolution that our children will devise. We shall laboriously acquire first-order adaptability and find that a second-order flexibility was needed. We may proceed along the road of progress that we have plotted, to discover that the vanguard is on an entirely different road.

The young man persisted. He had just left a small family concern in which the elderly chairman and managing director had kept a tight hold of the organisation which he had created. His early energies and inventiveness had, according to the young man, solidified in the mould of his own most fruitful years. "I could never forgive a man who refused to consider new ideas" the young man complained. "Look out," I continued, "your own ideas—these very ideas you couldn't get accepted—may in adversity become so precious to you, that you will likewise hold on to them when their usefulness is past."

Only recently have we began to see the first deliberate attempts to build change into the pattern of a lifetime. And how ridiculous do these first attempts appear. True conservatism may be the saving grace of age, and its most noble contribution. An open mind in any real sense is simply an abdication of responsibility. In industry where we force the pace on supersonic aircraft and nuclear power, we have yet to recognise the value of conservative restraint.

I think I must recently have crossed the House. An old man in a restaurant confided to me the other day as man to man: "The young are not as courteous as they used to be, are they?"

"No, they're not," I agreed.

Letters to the Editor

Need for a Review of Wheeled Traffic

SIR, It was significant in two separate ways, I suggest, that the Impact note rounding off your Road Traffic Review issue (ENGNG., 19 Feb. '60, p. 245) ended with the proposal that commuters' rail fares should be allowed as business expenses.

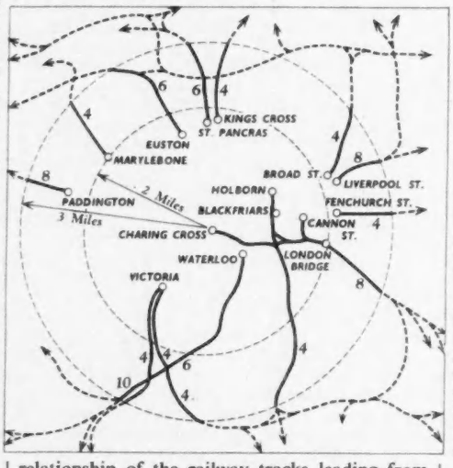
In the first place so tame an ending to a thoughtful review served to highlight the intractability of the railway problem. When ENGINEERING can only propose wheedling a handful of commuters away from their cars, on to the railways, while an avalanche of additional motor vehicles confronts us (2,000 a day), then surely we must be up against something!

In the second place, the significance of your proposal lay in its typifying the conventional "right hand, left hand" approach to the study of transport problems that, I suggest, bedevils the whole issue today. I refer to the strict separation of the study of wheeled transport in the two spheres, *rail* and *road*.

You reckoned without your host! British Railways cannot undertake to carry additional commuters! That was the whole tenor of the Institute of Transport lecture, on 10 January, by Mr. P. A. White, a traffic manager on the Southern Region of British Railways. He left his audience in no doubt whatsoever that British Railways are already extended to the limit in London. They have substituted 10-car trains for 8-car, at a cost of £3½ million; the lines in the inner London area are worked to capacity; and not even the North Kent electrification has enabled more trains to be dealt with at termini: "all normal methods have been exploited"; "unfortunately discomfort is no deterrent."

In the next ten years the population in the southern area will increase by 650,000, from among whom there will be 100,000 new commuters; the Kent lines are the most overstrained of all, and the additional 30,000 to 50,000 commuters expected there positively cannot be catered for; there must be "a new design for living," or (Heaven forbid!) new railways must be added to the old.

May I suggest, Sir, that ENGINEERING should next feature a Wheeled Traffic Review? It might lead somewhere. For instance, the dozen main lines serving London within a radius of 3 miles from Charing Cross muster a total of 70 rail tracks which—if these routes were paved instead of railed—would provide at least 70 free-flow road traffic lanes. The accompanying map shows the numbers and



relationship of the railway tracks leading from the London termini. If these routes were then reserved for buses, as they are now reserved for railway trains, the present maximum flow of British Railways commuters, which amounts to 240,000 in the hour 8.30 to 9.30 a.m. (and again at 5 to 6 p.m.), could be carried in 60-seat buses, on 40 of the lanes, at an average density of 100 vehicles per lane per hour: one per 36 seconds. In fact, a lane loading of 1,000 vehicles per lane per hour would be comfortably within the capacity of these routes.

The commuter problem is perhaps misnamed, and is being tackled at the wrong end in pestering people to stagger their working hours. An objective Wheeled Transport Review might clear up this and many other points that are befogged by long-standing preconceived notions about railways, typified in your calm assumption that British Railways would welcome more main-line commuters in the London area.

Yours faithfully,

T. I. LLOYD.

24 Grove Road,
Merrow, Guildford, Surrey.
23 February, 1960.

Track Costs

SIR, Your comprehensive special article entitled "Roads in the Transport Web" opens up a wide field for comments (ENGNG., 19 Feb. '60, p. 254).

In your remarks on the railways you rightly distinguish between:—

(*a*) Management, which should be given the same free hand as a private undertaking;

(*b*) Integration, for example, combined road and rail service which, as you say, should be retained as it constitutes one of the advantages of the British Railways services over its competitors; and

(*c*) Coordination, or the relations between the different means of transport, involving equal competitive conditions, payment on a commercial basis for essential non-paying services imposed on any form of transport, preceded by a general decision as to whether such services should be paid for by the taxpayer or by all users of transport; and objective track development to secure the cheapest transport for the community.

It has been suggested that the pooling of track costs, with an equal charge per unit of traffic to all means of transport, would be a logical way of obtaining this development. It would incidentally involve decisions as to the unit of traffic and for a review of the present distribution of road taxation, neither of which need involve practical difficulty once there is a transport policy.

Yours faithfully,

H. O. MANCE.

18-22 Abchurch Lane,
London, EC4.
23 February, 1960.

Work for the Waterways

SIR, I have read, with very great interest, your special article, "Roads in the Transport Web" (ENGNG., 19 Feb. '60, p. 254). I was pleased to find that it followed, in its general attitude, the principles suggested by Sir Ewart Smith at last autumn's meetings of the British Association; namely, that we urgently require a policy of transport coordination.

I was, of course, particularly interested in the paragraph dealing with the potential of water transport. This Association is entirely in agreement with Mr. H. E. Hopthrow, both in the remarks you quote and in his contention, supported by half the Bowes Committee, that *all* our inland waterways should immediately be removed from the control of the British Transport Commission and formed into a new Inland Waterways Conservancy. This, in the opinion of everyone who has given the subject serious thought, is the only way of saving the inland waterway industry from strangulation by an authority whose only object, incredible as it may seem, is suicide.

Another point brought up in your article deserves comment. It is, in fact, tied up with another, so I will deal with both as one. You state, in both cases quite correctly, that the waterways are of too small gauge for the greatest

economy, and that one of the difficulties in the way of canal development is the country's chronic shortage of water. However, a scheme, brought out at the beginning of the war, by Mr. J. F. Pownall, called the Grand Contour Canal Scheme, successfully deals with both these problems at once. Mr. Pownall proposed a ship canal on one level, 300 ft, with locks or lifts only at the ports, from Newcastle to Southampton, branching out to most of our industrial towns, many of which lie on this level. This enormous stretch of water would hold a volume of the order of the entire present artificial reservoir capacity, and, furthermore, would act as a vast pipeline in times of local drought, by sending, free of any transport other than gravity, water from wet areas to dry.

The cost of the scheme was, I understand, estimated at about £400 million at the time. When one considers the enormous sums spent on transport (according to Sir Ewart Smith about £5,000 million annually) this is not excessive. Full details of the scheme can be obtained from this association, 4 Emerald street, London, WC1.

I would further point out that, had the Contour canal been in operation at the moment, the ship you show unloading at Combwich could have brought its cargo direct from the factory. Being myself concerned with the production of the turbo-alternators and much of the reactor plant for Hinkley Point, I am in a position to realise the importance of this. Both Rugby and Stafford, where much of the station is being produced, are on the 300 ft line.

I am, Sir, your obedient servant,

M. J. MACFARLANE,
Honorary Joint Secretary.

Midlands Branch,
The Inland Waterways Association.
26 February, 1960.

Redress for Awkward Loads

SIR, Recently I was held up for over a quarter of an hour by a large load being transported by road for more than 200 miles from one seaport to another. This may have been economic for the manufacturer, but who considers the total economics from the point of view of myself and the dozens of other motorists who were inconvenienced?

Your article on "Road Transport Takes the Awkward Loads" (ENGNG., 19 Feb. '60, p. 264) makes no mention of this problem. It would be interesting to obtain from a legal expert an authoritative statement as to the legal position with regard to blocking the Queen's highway in this manner? Could I sue the firm concerned for inconvenience and loss of time, and have local authorities indeed the right to give permission for such loads to be carried? Incidentally, who pays for the police escorts?

Yours truly,

D. B. WELBOURN.

Engineering Laboratory,
University of Cambridge.
23 February, 1960.

Big Loads go by Sea

SIR, It was interesting to read your article entitled "Why Big Loads Are on the Roads" (ENGNG., 19 Feb., '60, p. 262).

During the early part of the construction at the Bradwell nuclear power station, Head Wrightson were faced with the problem of transporting the twelve huge heat exchanger vessels, each 100 ft long, 20 ft in diameter and weighing 200 tons, to the site from the company's works in the north-east of England. Loads of this sort were unacceptable by road and by sealing the vessels, each was launched down a slipway into the River Tees and towed down the east coast to the nuclear power station site.

This novel method of transportation avoided any congestion on the roads and enabled us to manufacture them completely in our works, with the obvious advantages that accrue when work is down in the factory rather than on the site.

I am happy to say that all twelve vessels have been safely dispatched now and that the journey of some 300 miles took on an average 48 hours.

Yours faithfully,

W. C. PATERSON,
Chief Publicity Officer.

Head, Wrightson and Company Limited,
London, SW1.
26 February, 1960.

Driving Tests

SIR, In view of Capricorn's philosophy on fools, it would be most interesting to know the accident rate among members of the Institute of Advanced Motorists and similar bodies. (ENGNG., 19 Feb. '60, p. 248.)

At least one motoring correspondent was involved in a very nasty pile-up, which he admitted causing, within days of satisfying Mr. George Eyles, the Institute's chief examiner.

Bearing in mind that L drivers of motor vehicles—as opposed to motor cycles—constitute the safest class of driver on the road, while police drivers, as a class, top the accident rate figures, I would ask in all humility, "What do driving tests as at present conducted prove?"

Perhaps the answer may be found in my own experiences. Of three provisional tests taken experimentally a short while ago, the examiners of my first and third tests emphatically disagreed with the "pass" result of the second. They were quite unaware of this of course. I had twice previously passed their own 90 minute test under the auspices of a chief area examiner.

Let's face it: neither the advanced nor any other test is capable of revealing the core of a driver's temperament. And yet it is there for all to see.

Yours faithfully,

WALLACE MATTHEW.

14 St. James,
Shaftesbury, Dorset.
21 February, 1960.

Vacant Seat Indicator

SIR, I was amused to see your note entitled "Checking Bus Route Loading," to the effect that London Transport are fitting switches in the seats of a vehicle to check the loading (ENGNG., 5 Feb. '60, p. 201).

On 13 May, 1946, Mr. S. A. Sweet and I took out a provisional patent (No. 612,158) describing such switches and an indicator which we proposed could give a continuous indication of the number of seats occupied (or unoccupied) on the upper deck of a vehicle; our device was called a "Vacant Seat Indicator." At the time there was a great deal of complaint about incomplete loading of buses at busy times, often due to the physical impossibility of the conductor making the necessary visual check at each stop.

Mr. Sweet and I were rebuffed by all the vehicle operators, coach builders and instrument manufacturers to whom we tried to sell our proposal, the rudest of which came from London Transport, who said, I believe, that they had thought of our idea too, but considered it quite impracticable.

I wish we had given that letter as much publicity as London Transport have given to their present experiment!

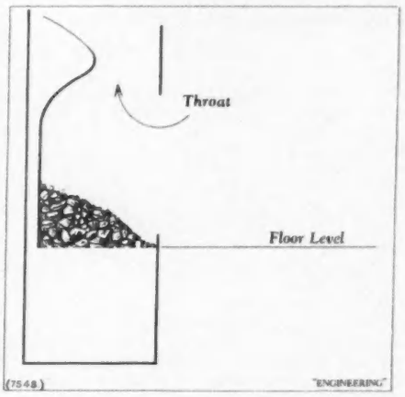
Yours faithfully,

DONALD F. WILKINSON.

1 The Chase,
Coulsdon, Surrey.
26 February, 1960.

Draughts in the Room

SIR, Referring to your interesting article on "No-Draught Fires" (ENGNG., 15 Jan. '60, p. 108) can anyone tell me why modern fireplaces are disposed with respect to the floor level as shown in the accompanying sketch instead of 18 in higher, as common until about 100 years ago? The old arrangement is more efficient in respect of getting radiant heat to the feet of people sitting



around, and ash catching and removal is easier than with low fires or well fires.

Are the latter a romantic revival of the cave men's appliances?

Yours faithfully,

O. KANTOROWICZ.

Cullercoats, North Shields.
23 February, 1960.

Concrete Strengths

SIR, I perused with interest Dr. J. M. Plowman's article on "Concrete Strength Near Freezing Point" (ENGNG., 15 Jan. '60, p. 78).

I would first like to answer the issue raised by Mr. Akroyd (ENGNG., 5 Feb., '60, p. 184) regarding the correctness of terming the maturity-strength relationship as Plowman's Law. Some of the interpretations given by *Chambers Twentieth Century Dictionary* for the term "law" are: "A theoretical principle educed from observation," "A statement or formula expressing the constant order of certain phenomena," etc., while the term "hypothesis" has been elucidated as "A supposition," "A proposition assumed for the sake of argument," "A theory to be proved or disproved by reference to facts," etc. Since Dr. Plowman has established his relationships not only by his own experiments, but also with reference to the research work carried out during the last 40 years or so, (*Magazine of Concrete Research*, No. 22, 1956, p. 13) it appears to me that it will be correct to term the relationship *only* as "law"; from the definitions quoted above, it would appear that, if the relationship is termed a "hypothesis," it would turn out to be a "Hypothesis Improperly So Called". It also appears to me that the work of John Austin has been quoted out of context for a purpose not intended by him, as obviously he has been lecturing on the province of jurisprudence.

With regard to the conclusions arrived at by Dr. Plowman in his article, I should like to state that my own research (carried out under the supervision of Dr. Plowman himself) indicates that at temperatures near 60° F, Plowman's Law operates only at maturities greater than 2,400° F-hours. Changes in the composition of cement and increase in fineness of grinding will cause a very rapid development of strength at early ages and, since the same rate of strength-development is not followed at later ages, the maturity-strength relationship follows a steeper pattern at early ages (that is, up to 2 days) than at later ages. Precisely the same effect was noticed by Dr. Plowman in his experiments with rapid-hardening cements (*Magazine of Concrete Research*, No. 24, 1956, p. 169). It would suggest, therefore, that the use of Plowman's Law be restricted to concretes cured continuously at normal temperatures (as contrasted to temperatures near freezing or boiling) and at maturities greater than 2,400° F-hours.

Yours faithfully,

R. NARAYANAN.

8, Tata Staff Quarters,
Wadala, Bombay 31, India.
25 February, 1960.

Time Saving on Clothes

At this year's International Clothing Trade Exhibition in April—the previous exhibition was held in 1958—there will be on show many types and styles of textiles and trimmings, in addition to accessories ranging from buttons and zips to fasteners and interlinings. One time-saving device on display will be the Holman check-matching unit which enables check-patterned materials to be accurately laid for bulk cutting (shown by Thomas Beecroft and Company Limited, Leeds).

Other short-cut techniques to be shown will provide for shirt-cuff setting in a single stitch, pressing coat lined flaps without basting, and pre-creasing garment components by means of a machine which combines a collapsible-type die with an automatic feedout. These processes, together with a power-driven low-cost pocket creaser, are due for exhibition by the Reece Folding Machine Company, Woburn, Mass., USA.

Overseas exhibitors taking part at the April exhibition will include firms from France, Germany, Italy, the Netherlands, Northern Ireland, Sweden and the United States.

Exhibitions and Conferences

Ergonomics Research Society, Annual Conference.—Mon., 28 Mar., to Thurs., 31 Mar., at the University of Cambridge. Particulars obtainable from Dr. S. Griew, University of Bristol, Department of Psychology, 22 Berkeley Square, Bristol 8. Tel. Bristol 24161, ext. 231.

Clothing Trade Exhibition and Convention, International.—Thurs., 7 April, to Wed., 13 April, at Olympia, London, W14. Organised by UTP Exhibitions Ltd., 9 Gough Square, Fleet Street, London, EC4. Tel. FLEet Street 3172.

Non-Destructive Testing Group, Institute of Physics.—Mon., 2 May, to Wed., 4 May, in London. Joint meeting with the Société Française de Métallurgie. Apply to the secretary, Institute of Physics, 47 Belgrave Square, London, SW1. Tel. BELgravia 6111.

Makers-up Fabric Assembly Exhibition, Second.—Mon., 23 May, to Fri., 27 May, at Berners Hotel, Berners Street, London, W1. Organised by UTP Exhibitions Ltd., 9 Gough Square, Fleet Street, London, EC4. Tel. FLEet Street 3172.

Aluminium for Use in Railway Rolling Stock, Symposium.—Fri., 27 May (10 a.m. to 5 p.m.), at the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. Organised by the Aluminium Development Association and the Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. Tel. ABBey 6672.

United States International Book Exhibition, Fifth.—Sun., 5 June, to Thurs., 9 June (at the Convention of the American Booksellers Association) at the Sherman Hotel, Chicago, Ill.; and Mon., 20 June, to Fri., 1 July, at the Low Library, Columbia University, New York. Organisers: The A.P. Wales Organisation, 26 Charing Cross Road, London, WC2. Tel. TEMple Bar 8947.

Lisbon International Fair, First.—Thurs., 9 June, to Thurs., 23 June, in the Exhibition Hall, Lisbon. Fair offices: Avenida da India, Lisbon 3, Portugal. Applications in the United Kingdom may be sent to the Casa de Portugal, 20 Lower Regent Street, London, SW1. Tel. WHItehall 2455.

British Exhibition and Trade Fair.—Fri., 10 June, to Sun., 26 June, at the Coliseum Exhibition Building, New York. Organised by British Overseas Fairs Ltd., 21 Tothill Street, London, SW1. Tel. WHItehall 6711.

Precast Concrete Industry, Third International Congress and Exhibition.—Thurs., 16 June, to Wed., 22 June, at Sankt Erikshallen, Storängsbotten, Stockholm. Organised by the Bureau International du Béton Manufacturé (BIBM), Brussels. Apply to the British Cast Concrete Federation, 105 Uxbridge Road, Ealing, London, W5. Tel. EALing 9621.

Military Electronics, Fourth National Conference on.—Mon., 27 June, to Wed., 29 June, at the Sheraton Park Hotel, Washington, DC, USA. Sponsored by the Professional Group on Military Electronics. Organised under the auspices of the Institute of Radio Engineers, Inc. Apply to Dr. Craig M. Crenshaw, Department of the Army, Office of Chief Signal Officer, Research and Development Division, SIGRD-2, Washington 25, DC, USA.

Institution of Electrical Engineers, Summer Meeting.—Mon., 27 June, to Fri., 1 July, in Scotland. Headquarters at the Central Hotel, Glasgow. Institution offices: Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Carbohydrate Chemistry, Symposium.—Tues., 12 July, to Thurs., 14 July, in Edinburgh. Theme: "Physical, Chemical and Biological Methods in the Study of High Molecular Weight Carbohydrates." Sponsored by the Chemical Society, Burlington House, Piccadilly, London, W1. Tel. REGent 0675.

Astronautical Congress, Eleventh.—Mon., 15 Aug., to Sat., 20 Aug., in Stockholm. Organised by the Swedish Interplanetary Society. The main sessions will be held at The Royal Institute of Technology, Stockholm. Offices of congress secretariat: IAF-60, PO. Box 5045, Stockholm 5, Sweden.

Non-Destructive Testing, Summer Institute.—Mon., 15 Aug., to Sat., 26 Aug., at Sacramento, Calif., USA. Apply to Asst. Professor George N. Beaumariage, Junr., Sacramento State College, 6000 Jay Street, Sacramento 19, Calif., USA.

Meetings and Papers

British Institution of Radio Engineers

BIRMINGHAM
"Transistor Power Amplifiers," by F. Butler. West Midlands Section. Matthew Boulton Technical College, Birmingham. Tues., 8 Mar., 7.15 p.m.

NEWCASTLE UPON TYNE
"Silicon Photo-Voltaic Cells in Instrumentation and Control," by Dr. A. A. Shepherd. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 9 Mar., 6 p.m.

Chemical Engineering Group

LONDON
"Application of the Engineering Sciences in the Chemical Industry", by H. Fossett. Tues., 8 Mar., 6 p.m.

Institute of Fuel

LONDON
"Nuclear Power for Ship Propulsion," by Dr. J. E. Richards. Institution of Civil Engineers, Great George Street, SW1. Wed., 9 Mar., 5.30 p.m.*

Institute of Information Scientists

LONDON
"The Nature of Human Communication," by Professor Colin Cherry. College of Preceptors, 2 Bloomsbury Square, WC1. Wed., 9 Mar., 6.15 p.m.*

Institute of Metal Finishing

LONDON
"Inspection and Testing of Organic Finishes," by R. J. Brown. Organic Finishing Group. British Institute of Management, 80 Fetter Lane ,EC4. Wed., 9 Mar., 6.30 p.m.

Institute of Physics

GLASGOW
"Biological Hazards of Radiation," by Professor J. Rotblat. Scottish Branch. The University, Glasgow. Mon., 7 Mar., 7.15 p.m.

Institution of British Agricultural Engineers

LONDON
"Equipment for Milking and Milk Handling," by H. S. Hall. Tues., 8 Mar., 2.15 p.m.

Institution of Chemical Engineers

LEEDS
"Recent Developments in Heat Transfer," by O. A. Saunders. North Western Branch. Houldsworth School of Applied Science, The University, Leeds 2. Wed., 9 Mar., 7 p.m.

Institution of Civil Engineers

LONDON
"Deep Excavations." Discussion introduced by V. H. Collingridge. Tues., 8 Mar., 5.30 p.m.*

Institution of Civil Engineers of Ireland

DUBLIN
"Computers and Their Application in Engineering," by Professor W. Wright and R. C. Cox. Mon., 7 Mar., 6.15 p.m.*

Institution of Electrical Engineers

LONDON
"An Introduction to the Theory of Masers, with Particular Reference to the Travelling-Wave Maser," by Dr. P. N. Butcher. Electronics and Communications Section. Mon., 7 Mar., 5.30 p.m.*
"Impulse Strength of Impregnated-Paper Dielectrics as Used in High-Voltage Cables," by Dr. B. Salvage and J. A. M. Gibbons. Supply Section. Wed., 9 Mar., 5.30 p.m.*
"Some Considerations in the Application of Power Rectifiers and Converters," by J. P. McBreen. Utilization Section. Thurs., 10 Mar., 5.30 p.m.*

BELFAST
"Recognition of Moving Vehicles by Electronic Means," by T. S. Pick and A. Readman. Northern Ireland Centre. David Keir Building, Queen's University, Stranmillis Road, Belfast. Tues., 8 Mar., 6.30 p.m.

NEWCASTLE UPON TYNE
"Protection of Electrical Systems," by H. G. Bell. Second Hunter Memorial Lecture. North Eastern Centre. Neville Hall, Westgate Road, Newcastle-upon-Tyne. Mon., 7 Mar., 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Some Uses of Computers in Shipbuilding and Engineering," by N. L. Lawrie. Tues., 8 Mar., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Some Problems in the Design of Crawler Tractors," by L. F. Little. Automobile Division. Tues., 8 Mar., 6 p.m.*
"Power, Flow and Pressure Measurements in Pump Testing," by Leslie Young and R. A. Nixon. Meeting in conjunction with the Hydraulics Group. Wed., 9 Mar., 6 p.m.*

MIDDLESBROUGH
"Design and Development of Machine Tools," by C. A. Sparkes. North Eastern Branch. Cleveland Institute, Corporation Road, Middlesbrough. Tues., 8 Mar., 6.15 p.m.

READING
"Harwell Protonsynchrotron," by P. Bowles. Southern Branch. Technical College, Reading. Thurs., 10 Mar., 7.30 p.m.

Institution of Plant Engineers

MANCHESTER
Annual General Meeting. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 8 Mar., 7.15 p.m.

Institution of Production Engineers

LEICESTER
"Developments in Dimensional Accuracy," by K. J. Hume. Leicester Section. Grand Hotel, Leicester. Thurs., 10 Mar., 7.15 p.m.

Junior Institution of Engineers

LONDON
"Refrigeration at Sea," by D. W. Higham. Fri., 11 Mar., 7 p.m.*

Physical Society

LONDON
"Electronic Music," by Dr. J. M. Bowsher. Acoustics Group. Physics Department, Imperial College, Imperial Institute Road, SW7. Thurs., 10 Mar., 5.30 p.m.*

Reinforced Concrete Association

BIRMINGHAM
"Theory, Research and the Practical Design of Reinforced Concrete," by W. E. J. Budgen. Midland Counties Branch, Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 8 Mar., 6 p.m.*

Royal Aeronautical Society

LONDON
"Electro Microcircuits," by Dr. J. W. Granville. Tues., 8 Mar., 7 p.m.
Symposium on "Vehicle and Instrumentation Problems in Upper Atmosphere Research." All-day discussion. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Fri., 11 Mar., 9.45 a.m.

Royal Society

LONDON
"Bernard Price Institute of Geophysical Research," by Dr. A. L. Hales. Thurs., 10 Mar., 4.30 p.m.*

Sheffield Metallurgical Association

SHEFFIELD
"Bonding Clays: Recent Work and Ideas," by Professor A. L. Roberts. Sheffield College of Commerce and Technology, Pond Street, Sheffield. Mon., 7 Mar., 7 p.m.

Society of Chemical Industry

SHEFFIELD
"Corrosion Problems of High-Temperature Pressurised-Water Reactors," by J. N. Wanklyn. Grand Hotel, Sheffield. Mon., 7 Mar., 7 p.m.

Society of Engineers

LONDON
"Progress of British Watch and Clock Production," by R. Lenoir. Geological Society, Burlington House, Piccadilly, W1. Mon., 7 Mar., 5.30 p.m.*

Society of Instrument Technology

LONDON
"Data Reduction for Guided Weapon Trials at Aberporth," by A. S. Younger, G. C. Morgan and E. S. Mallett. Data Processing Section. Manson House, 26 Portland Place, W1. Mon., 7 Mar., 7 p.m.*

BIRMINGHAM
"Reading with Electronics," by I. Merry. Midland Section. Gosta Green College of Technology, Aston Street, Birmingham. Fri., 11 Mar., 7 p.m.

LIVERPOOL
"Instruments of Interest." Various short papers. Liverpool Section. Offices of the Mersey and North Wales Electricity Board, Paradise Street, Liverpool. Thurs., 10 Mar., 7.15 p.m.

MANCHESTER
"Instrument Developments in the Oil Industry," by G. C. Elteton. Manchester Section. Central Library, St. Peter's Square, Manchester. Tues., 8 Mar., 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Engineering Group, 14 Belgrave Square, London, SW1. (BELgravia 3647)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Information Scientists. Apply to Mr. J. Farradane, Torran, Croft Road, Orpington, Kent.
Institute of Metal Finishing. Apply to 11a Gloucester Road, London, SW7. (KNIghtsbridge 9181)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institution of British Agricultural Engineers, 6 Queen Square, London, WC1. (TERminus 0140)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Civil Engineers of Ireland, 35 Dawson Street, Dublin.
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Physical Society, 1 Lowther Gardens, South Kensington, London, SW7. (KENsington 0048)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Society, Burlington House, Piccadilly, London, W1. (REGent 3335)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Engineers, Abbey House, Victoria Street, London, SW1. (ABBey 7244)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

Reconstruction of a Caribbean Harbour

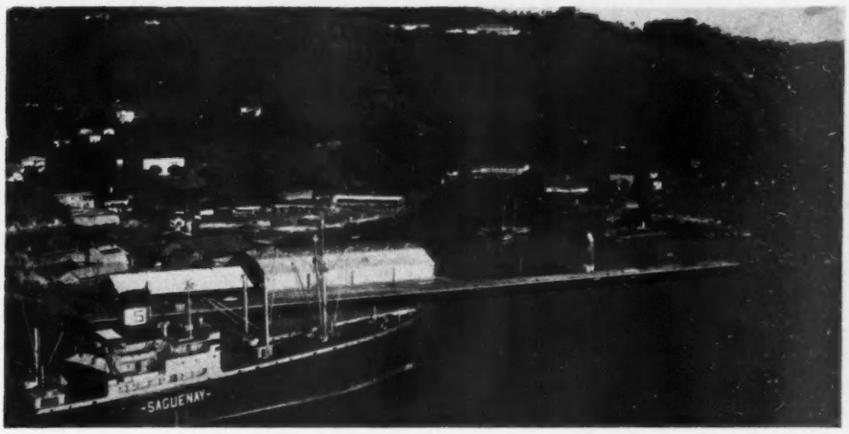
A £500,000 harbour works and pier has been completed by Holland & Hannen and Cubitts Limited at St. George's, Grenada, Windward Islands. It replaces the wooden deep-water pier destroyed by the disastrous Caribbean hurricane "Janet" in September 1955. Coode and Partners, of Victoria Street, London, consulting engineers for the Crown Agents, designed the new works and Cubitts started work in September 1957. The new harbour can accommodate two 5,000 ton ships and smaller island-to-island vessels.

The new pier occupies the same site as the old pier. An additional 3·3 acres of the old harbour, between quays and shore, has been reclaimed for extensions to accommodate a transit shed and banana shed. This reclaimed area is retained between two parallel rubble banks, 425 ft apart, running out westwards from the existing shore.

A jetty, 375 ft long and 36 ft wide, completes the L-shaped structure, giving a total frontage of 800 ft. The jetty and front face of the wharf are of heavy steel sheet piling.

Stone for the rubble banks was gathered from the river beds of the island by hand, transported in lorries and dumped straight into place. At one stage gravel was placed at the rate of 6,000 cu. yd per week. The area between the rubble banks was filled with laterite gravel in layers 2 ft thick which were then compacted by a 10 ton roller and a vibrating roller.

The heavy steel sheet piling in the front face of the wharf and in the jetty was 62 ft long, driven to a depth of 25 ft below the dredged level of the berths. This piling was of a special steel with a tensile strength above normal and a copper content for resistance to corrosion. The piling in the wharf was tied back by means of channel wallings and 2½ in diameter rods to a sheet piled anchor wall 60 ft behind.



New harbour and pier at St. George's in the Windward Islands.

As the bed of the harbour sloped steeply away from the wharf, rubble was dumped from a steel barge to stabilise the toes of the piles and bring the level of the harbour bed up to minus 30 ft.

About 2½ acres of the reclaimed area was paved with cold ashpalt macadam 3 in thick, laid over 9 in of hand pitched rubble. This surface was graded towards an open channel drain running across the wharf, with outfalls located in the rubble banks at its north and south ends.

Two steel framed buildings were erected on site. One, the banana shed, was a Fink truss building, 133 ft long and 58 ft wide, with open sides used for receiving bananas off-loaded from lorries. The second building used as a transit shed is an "Arcon" structure 20 ft high to the eaves and 38 ft to the ridge, with a clear span of 100 ft. It is 200 ft long overall, with a mass concrete retaining wall on its landward side to provide a loading platform for lorries. Corrugated aluminium, treated to reduce glare, was used for sheeting. Both sheds have been designed to withstand winds of speeds up to 100 m.p.h.

Local men comprised the labour force which reached a peak of 150, apart from six Europeans on Cubitt's staff. These local men built the two steel framed sheds although they had never been engaged on work of this nature before.

Strengthening a London Railway Cutting

London Transport engineers have started work on the replacement by a reinforced concrete raft of the well-known "Grid-Iron" bridge carrying their electrified Metropolitan and Circle Line tracks over the non-electrified lines about 300 yards west of Farringdon Station.

The original Grid-Iron was a wrought iron bridge built in 1867. It served a secondary purpose as a strut between the high retaining walls of the cutting at this point. The wrought-iron girders deteriorated and were replaced by the existing girders in 1892, but no provision was made for strutting the retaining walls.

Shortly after the Second World War, when the replacement of the iron work was again under consideration, slight signs of movement of the retaining walls were observed. This movement was slow and gave no cause for alarm until, in the spring of 1958, the rate of movement increased and had to be arrested by building concrete struts between the bases of the walls under the non-electrified tracks. It was found that the clay below the walls had deteriorated and that a permanent remedy would have to be devised.

The walls are to be stabilised by building a mass concrete invert, 180 ft long and 28 ft 6 in wide, between the walls and beneath the lower pair of tracks. This will strut the walls at the bottom, protect the ground from further softening, and also carry the surface water.

The eleven girders of the Grid-Iron are to be replaced by a continuous reinforced concrete raft 108 ft in length, to provide a new bridge deck. The raft will also act as a continuous strut between the retaining walls.

Working at weekends, the sections of the raft will be built in between the existing girders. The shuttering for each raft section will be erected during one Sunday possession and the reinforcing steel put into place. During the following Sunday possession, the shuttering will be propped from below and concrete will be placed in this section of the raft by pumping. Simultaneously, shuttering and reinforcement will be positioned for another section of the raft. As the girders of the Grid-Iron are unable to carry the weight of the raft sections as well as that of the passing trains, it is essential that each section be constructed and set to self-supporting strength within the duration of the possessions. For this reason, concrete of a very high early strength is being used.

When the ten sections have been built in this way, the girders will be removed and the gaps filled. The track will be ballasted.

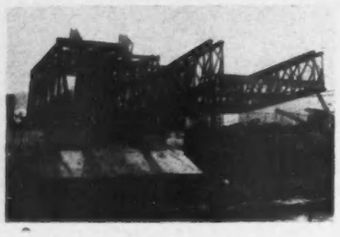
The work of replacing the Grid-Iron is being carried out by London Transport's own engineers under the direction of Mr. C. E. Dunton, M.I.C.E. The cost is approximately £50,000.

London Transport's "Grid-Iron" as it is today. It is being replaced by a reinforced concrete deck.

Steel Bridge Placed in Two Hours

A new bridge over the River Aire provides additional access to and from the Kirkstall Forge Engineering Works, Yorkshire. As shown by the illustration, it is a heavy steel lattice road bridge, and it was designed to carry abnormally heavy loads such as steel pressings weighing up to 100 tons. The clear span is 107 ft and the roadway 20 ft wide.

As there was adequate depth of embankment on each side of the river, it was decided to erect



Erecting a 107 ft span bridge using a Bailey bridge launching span.

the steelwork on one bank and launch it across the river using Bailey bridge equipment for the landing nose. The operation of launching and placing the bridge was completed in two hours.

The steel erection contractors were James Austin and Sons Limited of Dewsbury.

$5 Million Contract in Canada for UK Firm

A contract worth $5 million to build a new headquarters for Fords of Canada has been awarded to Taylor Woodrow (Canada) Limited. The site is near Toronto.

It will be a seven storey building having a total floor area of 180,000 sq. ft, and the architectural features will include a series of external vertical fins that will generate a grid effect and a " sawtooth " design of alternate porcelain panels and glass on the west elevation. The architects are Allward and Gouinlock of Toronto. Parking spaces and the road system around the site will allow for future developments.

The building will be completed by April, 1961.

Sharing the River Indus

The schemes being considered for the division of the waters of the River Indus between India and Pakistan will, when completed, have cost £360 million. Negotiations are still proceeding, but a statement issued by the World Bank in Washington suggests that a solution will be ratified about early May.

The expected treaty will be based on the proposals put forward by the Bank in 1954. This will mean that the three eastern rivers of the system will be available for the use of India and the three western for Pakistan. Major river training works will be required to implement the proposals.

Design and Maintenance of Soil-Aggregate Roads

Soil-aggregate roads are an economic proposition in rural areas where the traffic load is light. Such traffic must be low if maintenance is not to become excessive. Under these circumstances experience has shown that soil-aggregate roads, built *in situ* of materials locally available, can serve the travelling public at all seasons of the year without a great deal of maintenance.

Such roads are made by using a combination of any gravel, crushed stone and sand with silt-clay or other similar binding material. From their method of construction they are sometimes called a granular stabilised or mechanically stabilised road.

Based on the experience of the Illinois county highway agencies, and supplemented by information obtained from published literature, a *Manual of Current Practice for Design, Construction and Maintenance of Soil-Aggregate Roads* has been compiled by Eugene Y. Huang, associate professor of civil engineering at the Engineering Experiment Station of the University of Illinois. In his preface Professor Huang stresses that his book is intended to be used as a manual by district engineers and it has been written with their needs in mind; it is not a treatise for the specialist. Copies can be had from the Engineering Publications Office of the University at Urbana, Illinois, price $1.

New Fuel Oil Terminals

Work is about to begin on the £500,000 fuel oil terminal for the Regent Oil Company in Cardiff docks. Adjoining Alexandra Dock, the site is one of twelve acres, which has been leased from the British Transport Commission. Berths will be available for tankers of 16,000 tons.

The fuel oil storage will comprise six tanks for a total of 6 million gallons in three different grades. In addition, there will be storage for motor and domestic oils; for these lighter products there will be 18 tanks containing a total of 1,500,000 gallons and a lubricating oil warehouse holding 400 barrels of packed lubricants. Bunkering facilities for shipping in and out of Cardiff will also be provided.

Two contracts have been placed for the work. Whessoe Limited of Darlington are to supply and erect all the tankage. The main contract for all other aspects of the construction has been placed with Constructors John Brown Limited. It is expected that work will be completed by the end of 1960.

The Regent Oil Company are also going ahead with another £500,000 terminal, this time at Granton Harbour on the Firth of Forth, 1¼ miles west of Leith. Berthage on the West Pier will take ocean-going tankers of 18,000 tons. Storage will be provided for 8 million gallons of petroleum products that will include all grades of industrial and domestic fuel oil, petrols and lubricating oils.

Construction will be directly controlled by Regent's engineering staff and completion is expected early in 1961.

High Level Pavements to Speed Traffic

Greater efforts are to be made to segregate traffic and pedestrians. The Minister of Transport, Mr. Ernest Marples, is interested in any scheme that will raise the pavements to an upper storey level, simultaneously getting the pedestrians away from the traffic and releasing existing ground level pavements to widen the roadway and so speed the traffic. Such a solution would go some way to reducing the appalling accident rate on our roads. First floor pavements are not unheard of—rebuilt Coventry has some and the famous Rows at Chester are 400 years old—but there are many places where they could be installed relatively cheaply and with great advantage.

Mr. Marples was opening Castrol House, the new headquarters of the C. C. Wakefield group, when he put forward this suggestion. It was one of the points that is to be considered by the long term study group that he has established in his Ministry to look at the future development of our cities. We must, he said, " find a design for living in the last quarter of this century." The other point which the group is to consider immediately is the incorporation in buildings of off-street car parks that their own motors will require. This was a point on which he was able to congratulate the Wakefield group, for Castrol House is particularly well equipped in this respect. It can also be anticipated that the Minister will be quick to implement traffic engineering techniques; lane discipline by drivers will be " encouraged " and parking near to busy junctions very forcibly discouraged.

Insulation in Northern Building

A Canadian study has shown that, in the Northern areas, the economic thickness of insulation in buildings is 4 in of good fibrous material, and that 6 in is often justified even when the extra cost of 2 in by 6 in framing is taken into account. This result was obtained after allowing for fuel, transportation and installation costs during and after building.

It was concluded that reflective insulations and other thin insulations that depend on air spaces in the wall cavity are not well suited to extreme climates. Convection currents, air leakage, failure to obtain full sealing adjacent to framing members, and adverse effects of condensation on reflecting surfaces, all combine to make good results unobtainable in practice. Bulk insulation is more reliable but in addition large sheet vapour barriers of polyethylene should be used instead of, or as well as, the vapour barriers provided on the bulk insulation itself. Care should be taken when using compressed insulation to cut transport costs; many of these products do not possess adequate rebound properties when unpacked yet they are only as good as their rebound thickness permits. Foam-in-place polyurethanes offer extreme reductions in shipping bulk, but their high initial cost will off-set this advantage for some time to come.

The study was undertaken by the division of building research, National Research Council, Ottawa. Copies of the report, NRC 5280, price 25 cents, *Insulation in Northern Buildings*, by R. E. Platts, are obtainable from the publications section of the council.

Multi-Purpose Project in Southern Iran

The World Bank is to lend Iran the equivalent of £15 million for a multi-purpose power generation, irrigation and flood control project on the River Dez in Khuzestan. This is the area that contains most of the country's oil fields and, at Abadan, one of the world's largest refineries.

Work now to be undertaken comprises a concrete dam 620 ft high that will create a reservoir having a capacity of 2·7 million acre-ft. This dam will be located on the Dez in the upper half of a deep narrow gorge where the river breaks through the last mountain range before entering the coastal plain. Just below the dam an underground power house will be built and, initially, installed with two 65 MW generating sets.

Excluding the cost of the power distribution network, the cost of the whole scheme is put at £30 million, of which Iran has already spent £5 million. The dam, power station and the transmission lines are scheduled for completion by the end of 1962 and a pilot irrigation scheme by early 1964.

Pumped Storage in North of Scotland

The North of Scotland Hydro-Electric Board will shortly ask for tenders for the main plant for the Cruachen power station, part of the Loch Awe scheme.

The Cruachen section is a pumped storage project employing 400 MW of combined pumping and generating plant. Surplus generating capacity at night and over the week-end will be used to pump water up to a storage reservoir above Loch Awe. This water plus more that flows naturally into the reservoir will then be used to generate electricity in times of high demand.

Human Element

Where are the Engineer's Incentives?

The picture of the engineer lagging behind other professional men in reward, drawn last year by the Engineers' Guild survey, has now been heavily underlined by the publication of professional earning comparisons in the report of the Royal Commission on Doctors' and Dentists' Remuneration.

The Royal Commission surveyed nine other professions and a group—graduates in industry—in addition to examining the pay of five divisions of doctors, dentists and a general "all National Health Doctors" category.

Only in the early stage of their careers do engineers hold their own when their pay is compared with other professions. In the year 1955-56, to which all the figures apply, the average salary of the corporate engineers reviewed was £990 in the age bracket 30 to 34. Only for actuaries, £1,300, solicitors in England and Wales, £1,120, and university teachers, £1,060, was the average salary for the age group in advance of the engineers.

But in the very next group, 35 to 39, all the other professions examined had pulled ahead, except the architects, and from then on the engineers never caught up. Nor have they since, for there is no evidence that relative positions in the salary field have changed in favour of the engineer. In the 35 to 39 age group the figure for engineers was £1,140, actuaries and solicitors in Scotland had jumped to over £1,600 and the graduates in industry were close behind them at £1,580. The architects were still down at £980.

Unchanged

From then on the position of the nine professions and the graduates in industry stay unchanged in their relation to the architect at the bottom and the engineer next to it. The overall 30 to 65 medians for these professions were: actuaries—£2,020, solicitors in England and Wales—£1,850, barristers—£1,620, solicitors in Scotland—£1,580, graduates in industry—£1,570, university teachers—£1,510, accountants—£1,400, surveyors—£1,360, engineers—£1,210, and architects—£1,080.

While the results published by the Royal Commission show up the way in which this country neglects its engineers in relation to its other professions the same results show in a highly significant way that the penalty for achieving little success is harder in the higher reward professions than it is for the engineer.

One of the report's tables is of the lower quartile in salary comparison. This figure means that three quarters in the group will earn more and a quarter less. In the words of the report: "It provides an indication of the sort of income a not very successful person can command."

In the 55 to 64 age group the lower quartile for engineers was £1,220 while the same age group averaged over all the engineers in the survey had a salary of £1,650. This is very mild indeed compared with the penalty of being a not very successful barrister. The lower quartile for barristers is £680 in the 55 to 64 age group against an average for that group of £1,990. For actuaries the difference is between £1,850 and £3,010.

Still in the same age group the not very successful graduate in industry is shown by a salary of £1,680; the average for the group is £2,320.

Some of the 55-64 upper quartile figures, which the top quarter exceed: actuaries—£5,660, solicitors in England and Wales—£4,310, graduates in industry—£3,710, surveyors—£3,540, engineers—£2,310, and architects—£2,040.

It is an odd arrangement, and not by any means one that has always been so, that the men who design and modify the machines and products which set the pattern of the modern environment are next to bottom in the scale of professional recognition—taking reward as a highly valid index for esteem.

It may be that the painfully obvious ugliness of much modern building is the monument to undervaluing the architect. The lowered production and laggardly exploitation of ideas that may be the price of too little regard for the engineer is hidden to all but the most informed and is all the more dangerous.

Not What They Used to be

The trials and tribulations not only of travelling by train but also of being a railwayman can be manifold. They can also be unexpected.

At Derby the passengers, after years of complaints about services being late and unpredictable, are now complaining because the trains have regained the punctuality of the railways' golden age.

Strenuous British Railways' endeavours to equate the trains with the timetables have produced the almost inevitable result that regular travellers who have become used to a more casual way of doing things have been arriving too late even to see the formerly tardy carriages accelerating down the track.

Some parts of this story are out of character. Not only are the trains on time, but the travellers, abandoning their normal passive resignation, have been becoming "abusive" about it.

Perhaps when clean carriages are provided they too will cause indignant protest. After all, it will not then be possible to fling cigarette packets on the floor without a feeling of guilt.

Designing the Look of the Thing

The legion of consultants is a long and hard working one and entry to its ranks is, in the last resort, limited only to those who can advise a client how to do something better than he has the experience, inspiration or time to think up for himself.

One of the latest to enter the fold is the general consultant designer. The work of a leading member of this small but highly potent group, Mr. F. H. K. Henrion, has lately been seen in an exhibition at the Institute of Contemporary Arts in Mayfair.

There is nothing chi-chi or removed from the hard and practical world of industry about the consultant designers. Olivetti are as competitive a firm as any and they have used designers as well as artists and architects from wherever in the world they could find men of outstanding talent. The result in the interest of their products, and in the sales charts, is not hard to find.

At first sight it appears that the impact of the consultant designer, moving from problem to problem, never tied down in the cagey politics of one company and its staff relationships, must be entirely good. It is customary to hear these days described as grey and dreary but in reality, in addition to being dangerous and difficult, it is only necessary to look about to see that they are also bright and colourful.

If it is not given to the consultant designer to make life more pleasing and rounded at least he is able to make some of its fittings and equipment pleasing to look at, and that is a considerable step.

Sir Herbert Manzoni: New I.C.E. President

The new President of the Institution of Civil Engineers is Sir Herbert Manzoni, the Birmingham city engineer and surveyor. The 61 year old Sir Herbert succeeds Mr. A. C. Hartley who died in office in January.

An engineering student at Liverpool University from 1912 to 1915, Sir Herbert had his first professional engineering experience, after war service, with the Birkenhead Borough Engineer's office from 1922 to 1923.

Thirty seven years ago, in 1923, Sir Herbert joined the Birmingham authority as senior engineering assistant in the sewers and rivers department and from 1927 to 1928 was chief engineer in the department. For the next seven years he was the deputy city surveyor and in 1935 became city engineer and surveyor.

If the details of Sir Herbert's local authorities are brief, the list of his public positions is long and varied.

A leader in the development and application of standardisation techniques in building and civil engineering, Sir Herbert is a past president of the Institution of Municipal Engineers, and former chairman of the General Council of the British Standards Institution. Since 1954 he has been chairman of the Building Research Board of the Department of Scientific and Industrial Research. One of his many committees was the Bailey committee on the more rapid completion of house interiors.

One of the major works of his career has been the Birmingham Development Plan and its associated redevelopment schemes. An architect and a Fellow of the Royal Society for the Promotion of Health, Sir Herbert became president of the British Standards Institution in 1956.

Unified Field Theory for Chartered Engineers

Both centripetal and centrifugal forces—to borrow terms from the province of another institution—were seen to be at work during the Institution of Electrical Engineers' annual dinner. Sir Willis Jackson, President of the institution, proposed the creation of a common title uniting engineers from different disciplines; while Sir George Thomson, who as a physicist held electrical engineers in special regard, saw engineers irrevocably divided by dress traditions.

Civil engineers, he said, owed their origin to the first man who felled a tree across a chasm; their proper costume on ceremonial occasions should therefore be a combination of woad and skins. Mechanical engineers, who came into their own during the classical era, should take the toga as their social dress. Electrical engineers, on the other hand, were modern men, inheriting the formal wear of physicists like Faraday and Kelvin.

Sir Willis Jackson maintained that electrical engineers were very conscious of their fellowship with other chartered engineers. They must carry conviction not only as experts in their particular specialities, but also gain respect as ambassadors of broad vision, sound judgment and unshakable integrity. But confusion in the public mind between the various categories of men who nowadays were known as "engineers" detracted from the authority of chartered engineers.

Sir Willis considered that public appreciation of the engineering profession would be much enhanced if means could be devised to bring the members of its primary constituent branches together "under the common title of Chartered Engineer." Sir Willis was not proposing amalgamation, since it was essential not to restrain the vitality and initiative of the constituent branches; nor did he favour the creation of a superstructure of administrative machinery. What he desired was a "minimal device" which would ensure that chartered civil, mechanical, electrical and chemical engineers, in the first instance, were seen publicly to be members of an "integrated corporate body of Chartered Engineers."

The implications of this excellent proposal are profound. The engineering institutions, at present learned bodies of a predominantly technical cast, would be associated in a common professional role, leading perhaps to changes in their own character and constitution. Would such an association overlap, supersede, usurp or complement the functions of the Engineers' Guild? But there is much in favour of a "unified field theory"—to borrow from the province of Sir George.

No Ideal Home for the Handyman

Once again the crowds are flocking to Olympia to see there the latest in homes. The ideal home in fact and exhibition is the dream of hundreds of families, and newly weds; for how many can the dream be realised?

This year there are eight houses and bungalows in the village—four of each. They are fascinating whether American ranch house (a house, designed for real living) or English suburban. They have washing machines, refrigerators, dishwashers, floor warming, radiograms, Hammond organs, television—in fact everything for evening enjoyment with one glaring exception. In not one of them not even in the one furnished according to the *Practical Householder*, surely the epitome of home do-it-yourself, is there any room, place or corner where the master of the house (or for that matter the son) can drive in a nail or even glue two pieces of wood together. The nearest approaches are strong tables standing in junior's room in the American house and in the Georgian house.

This is a male challenge and all engineers and handy men should see to it that in the house of the future there is a room where they can do what they please unhampered by frills of muslin and pink roses that have invaded even the "smallest" room.

Charles Cooper

Former Joint Editor

It is with a deep sense of personal loss, which will be widely shared, that we record the death on 24 February, at his home in Northwood, Middlesex, of Mr. Charles Cooper, formerly Joint Editor of ENGINEERING. He was 76 years of age and had been associated with this journal for more than 60 years, having joined the staff in 1897 and being still a Director at his death.

Charles Cooper was a Londoner and was born on the 22 September, 1883, in the Borough of St. Marylebone, where also he received his schooling. It can have been only elementary, for he was still under 14 years of age when on 15 July, 1897, he first presented himself in the office of ENGINEERING. How this came about is a good example of how one small episode may shape the course of a life. He had lost his father in infancy, but his mother continued to live in the same district, close to Lord's cricket ground, where they had as a neighbour a relative of Sir Charles Bright, the telegraph engineer. This gentleman chanced to remark to Mrs. Cooper, in the hearing of young Charles, that he was shortly going abroad and was much concerned to know what to do about the care of his dog. Charles, a dog lover even then and for all his days, begged to be allowed to look after it. The dog's owner, on his return, learning that the boy would shortly leave school, and having heard from B. A. Raworth, then an assistant editor of ENGINEERING, that a boy was wanted in the editorial department, gave him an introduction. So the pattern of his life was set.

His wages were 7*s* 6*d* a week and his duties were press-copying letters, keeping various minor records, running errands, and answering the telephone. There was only one telephone instrument, of the old-fashioned type with a fixed mouthpiece. The number, 3663, is still that of ENGINEERING, but at that time there was no exchange name prefixed. Later, it became Gerrard 3663, and eventually TEMple Bar 3663. The instrument was mounted on a pillar in the counting house, and because the transmitter was too high for the diminutive Cooper to reach, a wooden box was provided for him to stand on.

Before long his duties were extended to the checking of blockmakers' charges, which entailed measuring up the blocks—woodcuts as well as line and half-tone—and calculating the charge at so much per square inch. From this routine job he progressed to checking the re-drawn line drawings against the originals; an introduction to engineering detail from which he learned much. He was still only an editorial clerk; but presently Raworth set him to writing occasional news paragraphs—and edited them in his presence, to show how they could be improved. At about this time, too, the staff shorthand-writer, J. T. Ellis-Fermor, who was a master of good English, impressed upon him that he could not expect to go far with only an elementary education, and urged him to study for the London Matriculation.

It was in this, perhaps, that Cooper really showed the traits of perseverance, concentration and a capacity for work which were later to astonish and sometimes to dismay his colleagues. He took the proffered advice, signed on at Chelsea Polytechnic, and attended evening classes there in English, French, mechanics, mathematics, and electricity and magnetism for some three years, until, in 1905, he did matriculate. Then he went on to pass the Intermediate (Engineering) examination two years later; but there, for a time, he halted—the task of training for the Final B.Sc. (Engineering) seemed too much, on top of a full working week. Some years later, however, a friend who had done it persuaded him to continue, and in July, 1914, he obtained his degree. One of his classmates at Chelsea during his Finals course was a young man named McCance, now Sir Andrew McCance, D.L., D.Sc., F.R.S., chairman and managing director of Colvilles Limited, the steelmakers.

On the outbreak of war less than a month later his new qualification speedily proved of value. To meet the demand for munition workers, Vickers Ltd. had set up an evening training school in Westminster, staffed with voluntary instructors, of whom Cooper was one. When the firm began to build aircraft in quantity, their chief designer, R. K. Pierson, felt the need for a wind tunnel and obtained Government permission to build one. He also needed someone to operate it and, by arrangement, Cooper was appointed. Under Dr. (later Sir) Leonard Bairstow, he spent six months in the Aerodynamics Division of the National Physical Laboratory, and then, when the new Vickers tunnel was completed at St. Albans, was sent there in charge of it. Thus it came about that he was directly concerned in the tunnel-testing of the Vickers Vimy aircraft which, in June, 1919, made the first non-stop air crossing of the Atlantic.

Early in 1919 Cooper had returned to ENGINEERING, and, to his great satisfaction, had been appointed a member of the editorial staff. He was now an Associate Fellow of the Royal Aeronautical Society and was regarded as the expert on all matters to do with aviation; and, through his work at the N.P.L. and at St. Albans, had acquired an extensive acquaintance among research physicists, and among scientific instrument makers, such as R. S. Whipple of the Cambridge Instrument Co., and Frank Twyman of Adam Hilger Ltd. He was ready to turn his hand to any editorial work—with the sole exception of leader-writing, for which he always maintained he had no aptitude—but he was at his best on scientific descriptions. Thus it came about that he became something of a specialist on astronomical telescopes and other apparatus, on radio-communication, and then on television—his friendship with John Logie Baird went back to 1925.

In 1920 he was sent to Cardiff to report the discussions in Section G (Engineering) of the British Association, and so began a personal connection with the work of Section G which extended over 36 years. At first, he attended solely as a reporter, writing up his notes every night and posting them to London from wherever the meeting might be. Soon, however, the quality of his reports, and his evident knowledge and interest, so impressed the engineers and scientists responsible for organising the programmes that, for many years, he was consulted in the compilation of them, and often assisted them to find speakers to deal with specialised subjects. At the Birmingham meeting in 1950, when Professor Andrew Robertson was President of Section G, Cooper's work for the Section was recognised by a dinner given in his honour. It was well deserved, for, thanks to him, many notable discourses were recorded, which otherwise would not have been preserved at all; though this applies even more to his reports of lectures to the Royal Institution, such as those of Lord Rutherford. The late H. M. Martin reported these regularly until his death in 1933. Cooper, who admired Martin greatly and had benefited much from his friendship and guidance, was the obvious man to continue with the work, which he did until quite recently.

Dr. W. H. Maw died in 1924. After the death of Raworth in 1919 Sir Alexander Richardson had succeeded him as Joint Editor with Maw, and for a short time he now continued alone as Editor. Then he resigned, and the practice of having two Joint Editors was re-introduced, P. J. Cowan and H. H. Johnson being appointed; both had been for some years on the editorial staff. When Cowan resigned in 1939, Johnson decided to retire also, and on 1 March in that year Charles Cooper and J. Foster Petree took office as Joint Editors, Cooper occupying the same desk and the same chair that Maw had used when he engaged the new office boy in 1897.

The two new Editors had hardly established their *modus operandi* before the Second World War broke out. In the work of producing the paper, Cooper had by far the greater experience and on him, therefore, fell the larger part of the burden of constant re-organising as the war-time conditions changed, almost from week to week. His colleague did more writing and travelling than he, but Cooper, throughout the war, read the proofs of every page of every issue, and handled all matters of illustration; and never was his vigilance relaxed or his standard of clarity and accuracy lowered. The strain was greater than he admitted, or perhaps realised at the time, for after the war he seemed to find it impossible to relax, until at last his health gave way. A long holiday in Switzerland did him much good, but obviously a less strenuous time-table was imperative. At the end of 1949, he gave up most of his responsibilities as Joint Editor, though remaining on the Board and still spending much time in the office. He hoped to stay the course until 15 July, 1957, when he would have completed 60 years, but his heart had begun to give trouble, necessitating hospital treatment, and at the end of 1956 he retired. He paid regular visits to Bedford Street, however, until a few months ago, though for a year or more he would seldom venture to climb stairs, but was content to " hold Court " in the reception room. A comparatively minor operation, which he underwent in December, weakened him more than was expected, but he rallied well, until his sudden and fatal relapse last week.

The death of one who has been so long and so intimately associated with the familiar scene naturally recalls a host of personal memories which, in print, must lose much of their force. Martinet though he was in matters editorial, Cooper was essentially a friendly and sociable man, never happier than when, in the National Liberal Club, he could like Dr. Johnson, " cross his legs and have his talk out "—and he could talk well of many things. His reading was wide, though when he found time for it was a mystery, and his memory for detail was astonishing. At Northwood, where he had lived for many years, he was a keen supporter of the local scientific society and had served as its President. When over 60 years of age, he became a Freemason, in the Whittington Lodge, No. 862, but felt himself too old to undertake office, though he enjoyed greatly the companionship of his fellow members and attended regularly until failing health obliged him to curtail this with his other activities. So, towards the end, reading became his chief solace.

ENGINEERING has been served by many men of character and ability, but, it can be safely said never more devotedly than by Charles Cooper.

Special Article

Phase Three in Electronics

The evolution of electronics can be said to have had two main phases: the first was that of the thermionic valve; the second that of the transistor. Now a third phase is about to begin.

When Sir Ambrose Fleming devised the thermionic valve, in 1904, he unwittingly began the first major phase in the evolution of a branch of engineering that has since had far reaching effects on all forms of human industry. His device, the diode, was later developed by the American Lee De Forest, and others, into a range of thermionic devices which are known as valves in this country, and "tubes" in the USA. These devices could be described as "primary elements," which enable complex functional electronic systems to be constructed.

The reign of the thermionic device as the primary electronic element could be said to have lasted about half a century from the date of its conception, whereupon it was vigorously and successfully challenged by the transistor and other semiconductor devices, thus creating a second phase in electronic development.

Although semiconductors are able to perform many of the functions of thermionic valves, they are in no way physically similar. For instance, a valve is normally a vacuum device in which electrons are liberated from a red-hot metal and then moved through free space; whereas in a semiconductor all the electron movement takes place in a small, cold, solid crystal.

Because of these physical differences, transistors are very much smaller and lighter than valves. In addition, transistors have the advantage that they require far less power and much lower voltages for their operation and consequently generate only a slight amount of heat.

With so many technical advantages then, to say nothing of their economic superiority, transistors can well be said to have taken over the dominant position in the field of electronics. However, in the light of more recent developments, it would appear that their reign is to be comparitively short lived.

MOLECULAR ELECTRONICS

News has recently come from the United States, the undisputed mecca of electronic development, of a new concept of electronic circuitry, wherein entire functional systems can be formed within the domains of a single solid state device. That is to say that an electronic circuit, which would normally consist of a number of elements, can now be replaced by a single crystal element. These new elements are called "molecular electronic function blocks."

Fig. 2 The encapsulated element, being held in the hand, is a light telemetry "molectronic" subsystem. It has an a.c. output having a frequency proportional to the ambient light intensity.

The name of these devices drives from the fact that they are dependent upon phenomena which occur within or between the domains of molecules in the solid state. By suitable arrangement, the devices can be made to simulate capacitors, resistors, transistors, inductors, and other electronic building blocks, so that it is possible to build into a single crystal a number of molecular domains in such a way that they will simulate a given system of normal electronic elements.

The dramatic effect of this "intermolecular circuitry" can clearly be seen in Fig. 1, in which a molecular electronic function block is placed beside its "phase-one" counterpart. These two apparatuses perform the exactly similar functions, although their physical dimensions differ by several orders of magnitude.

Fig. 1 The small object being held with a pair of tweezers is a molecular electronic amplifier which performs the same function as the conventional amplifier on the table.

In addition to the enormous reductions in size and weight, another advantage of "molectronic circuits" is that they are inherently more reliable than their conventional counter parts. In fact, a single crystal molectronic subsystem is said to be as reliable as an ordinary transistor. Therefore, since the reliability of a transistor circuit is only as good as the statistical sum of the reliabilities of all the various components and soldered joints, it follows that the molectronic circuit is more reliable by a wide margin. In fact its reliability may, in some cases be several orders of magnitude better than its transistor, or valve, circuit counterpart. This is of paramount importance in cases where equipment servicing is out of the question—such as in submarine cable amplifiers and space satellite instruments.

There are many physical effects known to the solid state physicist which can be built into these devices, such as the well known thermcelectric effects (Peltier, Seebeck, etc.), the Hall magnetic effect, and photoelectric effects. Sensitivity to these phenomena makes the molectronic device eminently suitable for use in telemetry systems, where information in the form of light intensity, magnetic field intensity, radiant heat, etc., are the input and radio signals are the output. These systems are used in high-altitude rockets and satellites to transmit information about the atmosphere, and about space itself, back to Earth. Needless to say, size, weight and reliability are major considerations for such equipment. An example of a molectronic telemetering device is shown in Fig. 2, where the element being held in the hand is a high-output amplifier, working directly from an optical light input.

The major centre for molectronic research and development is the Westinghouse laboratory at Pittsburgh, Pennsylvania, USA. The terms of reference for their research programme, which is being carried out jointly with the Wright Air Development Centre under the auspices of the United States Air Force, are as follows: "To determine to what extent molecular electronics can be used to perform complex functions in several systems of basic importance to the Air Force; to develop subsystems for use in those systems; and to develop new materials that will advance the usefulness of the concept."

In their efforts to develop workable subsystems, Westinghouse have, so far, been successful beyond even their own expectations, as was recently shown when their work was made public. One of the subsystems demonstrated was a high quality audio amplifier with an output of five watts (when used with a heat sink) and a frequency range of 0 to 20 thousand cycles per second. In size it is little bigger than a sixpenny piece. Other successful circuits include video amplifiers, tuned amplifiers, multi-vibrators, logic switches and an analogue-to-digital converter employing an n-p-n-p relaxation oscillator.

During the next year or so, Westinghouse hope to continue with their development of the molecular electronic technique, to increase the range of functions still further. They will also devote some effort to the mating of their present subsystems, in order to develop a complete functional equipment using only molectronic techniques. One specific objective is to be a molectronic VHF communications receiver.

When one considers the short life-span of electronics it is plain to see that its technological progress occurs at a rapid rate. However, what is not so plain is that even this rapid rate of progress is increasing all the time. There was something like a twenty-year interval between the invention of the thermionic valve and its first significant applications, but, less than half that amount of time lapsed between the invention and the first use of the transistor. Now, it is believed that the widespread use of the molecular electronic concept will begin in only three to five years; first in space instruments and various military equipment then, soon after, in industry and elsewhere.

A more detailed article on this subject appears on pages 338 and 339 of this issue.

Driving Experience with Wankel Engines

In little more than six years, the NSU Wankel engine has become a practical power unit. Installed in a car, it has completed over 16,000 miles with a performance of 60 m.p.g at 30 m.p.h.

By Gordon Wilkins

A recent visit to the NSU works at Neckarsulm shows that development of the NSU-Wankel engine has already proceeded some way beyond the stage indicated in the paper recently presented to the VDI by Felix Wankel and Dr. Froede, chief development engineer of NSU. Experimental 250 c.c. engines are already running on the road in two NSU Prince small cars, one of which has done nearly 16,000 miles and the other has done nearly 9,000 with very satisfactory results.

The first type of engine, the DKM in its various forms, had both rotor and outer casing revolving, which introduced numerous complications. The carburettor fed mixture into the hollow rotor shaft, and so into the interior of the rotor, from which it emerged through ports into the working chamber. The rotor contained three sparking plugs so that the engine would have to be stripped to change a plug. Both rotor and casing were water cooled. The mechanical and sealing problems were obvious and among the performance disadvantages was a sharp rise in specific fuel consumption below a speed of 6,000 r.p.m.

The original layout was abandoned in favour of the present type, with fixed housing of epitrochoid form in which a three-pointed rotor travels on an eccentric path while turning about its own axis. The first unit was of 125 c.c. capacity with water cooled casing and rotor cooled by lubricating oil. With an aluminium-silicon casing it weighed 24·2 lb and with cast iron, 37·4 lb. Rotors of both aluminium-silicon and cast iron were tried. A specific fuel consumption of 250 grammes per b.h.p. per hr was obtained between 6,000 and 10,000 r.p.m. and the maximum output was 26 b.h.p. at 11,000 r.p.m.

Introduction of the small engine was followed by the KKM 250, a 250 c.c. unit on which research and development is now being concentrated. With 8 : 1 compression ratio, this originally gave 29 b.h.p. but the output is now nearer 40 at 11,000 r.p.m. About 30 b.h.p. is obtained in the units used in the cars, which are held down to 8,000 r.p.m. to permit the use of standard auxiliaries such as dyna-starter, water pump and clutch. This engine is already giving quite good low-speed fuel consumption. It does 260 grammes per b.h.p. per hr at 7,000 r.p.m. and not over 300 grammes at 2,000 r.p.m.

The rotor gearing on these engines consists of an internal toothed ring in the rotor, with 45 teeth engaging with a fixed gear having 30 teeth on the housing end face. Thus engine torque is not transmitted through the gears, but through the eccentric integral with the engine shaft, which makes three revolutions for one revolution of the rotor. At present the shaft journal bearings consist of one ball and one roller bearing. The rotor was originally to run on needle rollers, but a four-row caged roller bearing has been substituted. This arrangement was adopted to ensure freedom from bearing problems during investigations into other aspects of engine design and performance, but Dr. Froede is confident that the engine can be run on plain bearings throughout.

Shaft and rotor bearings are lubricated by oil under pressure which also serves to cool the rotor. Oil flow is at present about 3 litres per min, a little more than would be used for a piston engine of similar power. Heat input to the oil is similar. An ingenious scroll collector projects inside the rotor to control the oil level and prevent excessive " cocktail shaker " losses.

The rotor seals illustrated in the VDI paper have already been superseded by a simpler arrangement derived directly from piston ring practice. Tip seals and side seals on the rotor are simple strips of centrifugally cast iron backed by crinkled spring steel strips. They are all retained in place by spring-loaded trunions in the sides of the rotor near the tips. Lubrication was originally provided for the seals by mixing oil in the petrol in the ratio of 1 : 50. This was reduced to 1 : 200 and at this strength has been used successfully in a bench test of three hours at full throttle, with 150 lb per sq. in b.m.e.p. Curtiss-Wright, licensees for this engine in the USA have run engines successfully without any oil in the fuel.

Development of the engine is only beginning and it will take a long time to explore its full possibilities, but progress has been extraordinarily rapid since NSU first decided to put Wankel's ideas into practice in 1954. Dr. Froede says a thorough search of the patent files disclosed about 1,000 possible shapes for such an engine, most of which were rejected as useless on the grounds that they were impossible to seal or too complex mechanically. The Wankel epitrochoidal form meets three essential conditions: it can be cooled, the spaces between rotor and casing can be sealed, and the ratio of working volume to total volume is high. The result is a light, compact engine with a low rubbing velocity for the seals.

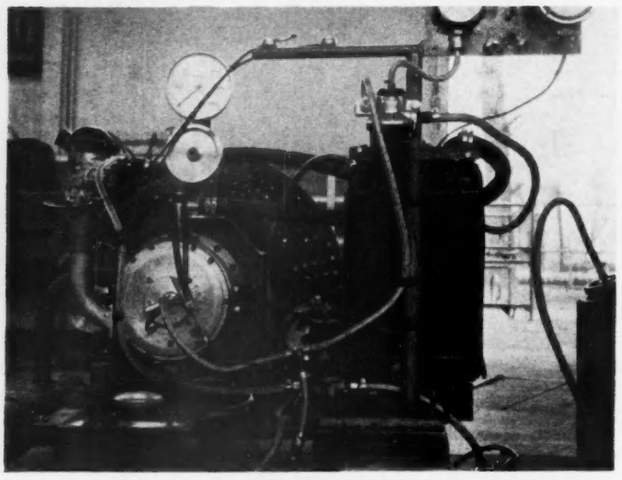
Some tests have suggested that increased revolutions reduce seal wear and it is believed that above 10,000 r.p.m. a pneumatic seal may be developed to supplement the effects of centrifugal force on the rotor seals. Several geometrical points have also been revealed by bench tests. Engines have been run with peripheral inlet ports and with inlet ports in the end face of the casing. The end face port gave slightly better fuel economy, but the peripheral port held the advantage of higher maximum power. It is believed that with the latter there is slight loss of fresh charge through the exhaust during the overlap period. But motoring tests with a peripheral inlet on the 125 c.c. engine have showed volumetric efficiencies of 115 to 120 per cent as a result of induction ram effects, and it is considered that maximum power could be retained with lower fuel consumption by using a peripheral inlet in conjunction with fuel injection.

Most published diagrams have shown the sparking plug in the same lobe of the casing as the exhaust port, but better results have been obtained by moving it across the " waist " of the chamber into the same lobe as the inlet port. The flame then travels with the gas stream and not against it. In spite of the long, shallow combustion chamber, so different from that found desirable on piston engines, resistance to detonation is extraordinarily high and engines have run successfully on fuel of 40 octane at compression ratios between 7 and 10 : 1.

As installed in the rear of an NSU Prince car, the 250 c.c. engine is almost hidden by the dyna-starter, water pump, carburettor, air cleaner and clutch housing. This experimental installation uses an oil cooler from a Volkswagen and the water pump and radiator from a Fiat 600. Work is proceeding on an air-cooled casing, which will be essential before these engines can be produced for scooters and motor cycles.

Starting is quite easy at a cranking speed of about 500 r.p.m. and the engine runs without any perceptible vibration. Response to the throttle is immediate and the exhaust note is rather like that of a two-stroke without the unevenness at low speeds. As there is only one exhaust impulse for each revolution of the engine shaft, the exhaust note gives no indication to those accustomed to the sound of normal car engines of the exceptionally high revolutions attained. Maximum torque is delivered at 5,500 r.p.m. and the engine in its present form is not very flexible. Fairly frequent gear changing is necessary to keep the engine speed above about 3,000 r.p.m., the speed needed to secure adequate acceleration. Because of the greater range of engine speed, gear changing is slower. Unless ways can be found of increasing low-speed torque without an unacceptable rise in specific fuel consumption, a different transmission, with more and closer steps, will be required. But even with the present standard gearbox, the car has slightly better acceleration than with the standard two-cylinder engine. The maximum speed is about 70 m.p.h. Fuel consumption checks have shown about 60 m.p.g. at a steady 30 m.p.h. and 36 at a steady 60.

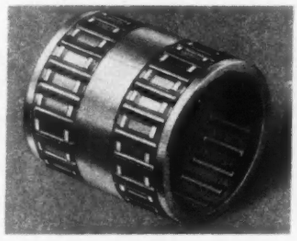
Obviously the automobile application is the most difficult one, and the results obtained after such a short development period are very promising. The simplest application is the constant speed engine driving pumps, etc. The next would be marine and aero engines where power output is proportional to revolutions. In the USA Curtiss-Wright already have a 160 b.h.p. 1-litre engine in operation and are building a 600 h.p. aero engine composed of four Wankel units in line with twin ignition.



A KKM 250 NSU-Wankel engine showed easy starting and even idling. The exhaust note is rather like that of a two-stroke engine, without the unevenness at low speeds.

NEEDLE CAGES

Direct Running on Shafts



THE INA range of needle bearings includes cage assemblies that dispense with outer and inner races.

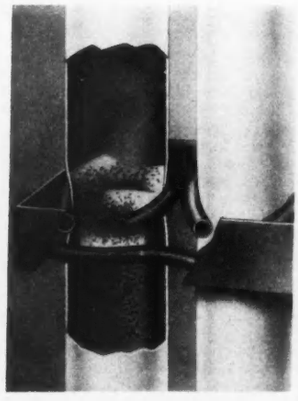
Such assemblies reduce the overall size of the bearing and are becoming more frequently used as the hardening of shafts has developed. Shaft and housing can be ground to the exact running size required, so that running clearances can be calculated beforehand to a high degree of accuracy. The arrangement also dispenses with the tiresome fitting of races. Bearings can also be suppled in stainless steel, making them suitable for use in the food industries or elsewhere.

The needles are held firmly in the cages both externally and internally. The slots support each needle over its entire length and provide for adequate lubrication. The needles in any one cage are selected to have a diametric group tolerance of $\pm 1\,\mu$ (0·000,04 in) to ensure running accuracy and even load distribution among them. The cages can be supplied as single-row units with solid cages; single-row units with split cages; double-row sets; and sets for special applications like big end and wrist pin bearings.

The shafts on which the rollers are to run should be hardened to 62 ± 2 on the Rockwell C scale and the surface ground to less than 1μ if possible. The double-row assemblies have the rows staggered and are designed for heavy loadings on long bearings. They allow the needles to take up the load over their entire length which might not be possible for single needles of the equivalent bearing length. A very wide range of sizes is available. *INA Needle Bearings Limited, Dafen, Llanelly, Carmarthenshire.*

BAG FILTER

Air Jet Cleaning



NOW to be made in this country is the Holmes-Retroflux bag filter which has continuous cleaning by air jets.

The illustration shows portions of two of the filter bags which are fed from a common header. Dust from the air settles on the insides of the bags and some gravity settlement also occurs as the air speed is small. The cleaned air escapes radially. Round each of the bags are two jet tubes set 3 in apart with slots that blow air at high velocity on the bags. The jets are set at right angles to each other. The high velocity air slightly deforms the bag to an elliptical shape and dislodges the dust which then falls to the bottom.

The jet tubes are mounted on a frame which travels slowly up and down the bags so that the whole length is cleaned. The movement is said to be slow and gentle so that wear on the fabric of the bags is kept to a minimum. At the foot of the bags is a hopper or a worm conveyor to remove the dust.

An efficiency in excess of 99 per cent is guaranteed for all particles down to sub-micron size. The filters are made in a large range of capacities: a single frame can clean up to 36 bags. In larger sizes the frames are mounted in counterbalanced pairs. *W. C. Holmes and Company Limited, PO Box No. 7, Turnbridge, Huddersfield.*

TOOL CHESTS

Wall or Bench Mounting

A COMPACT bench mounting 40-drawer tool cabinet is now on the market.

The chest is constructed of $\frac{5}{8}$ in parana pine, stained and polished. The drawers measure 8 in by $3\frac{1}{2}$ in by $1\frac{1}{8}$ in inside and are made from beech with plywood bases and fitted with plastic handles.

Four sizes of chest are made: the smallest has only 18 drawers and measures 14 in by 9 in by 9 in overall. The largest measures 23 in by 12 in by 9 in and accommodates 40 drawers. They are suitable for storing drills, taps, dies, and other small tools or parts.

The firm also make wall mounting storage cabinets, the largest of which also has 40 drawers. It measures 1 ft high and 3 ft long. Each drawer is made of non-corrosive rustproof Zyntax and the frame is finished in blue hammered stove enamel. There are 12 drawers 1 in deep, 18 of $\frac{3}{4}$ in deep, and 20 of $\frac{1}{2}$ in deep. All drawers are $6\frac{5}{16}$ in long and 3 in wide. *General Trade Equipment, 82-90 Seymour Place, London, W1.*

TEMPERATURE RECORDER

Sensitive to 0·01° C

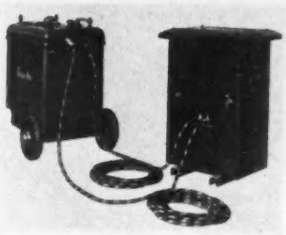
THE Sentichart temperature recorder is sensitive to relative changes of temperature of the order of 0·01° C.

The instrument uses a bimetallic helix, the movement of which is magnified by an actuating arm. This arm in turn applies a small force to a parallel spring motion within a pneumatic servo system, where it is multiplied some 70 times to operate the pen arm. The pen arm again multiplies the movement.

The pneumatic servo system operates by means of a flapper plate on the parallel motion, set between opposed orifices held at a fixed distance from each other on a yoke mounted on rubber capsules. A small force on the arm unbalances the system, which, in restoring the balance, moves the pen arm and makes a recording on the chart. The range of temperatures that can be covered by the helix is from −75° C to +175° C, the full scale deflection on the chart being 0·3° C at any one setting. *Techne (Cambridge) Limited, Duxford, Cambridge.*

WELDING RECTIFIER

Portable Plug-in Unit



A NEW portable direct current power unit has been introduced. Made by Quasi-Arc, it is the PR 250 plug-in rectifier.

The unit is designed as an inexpensive and convenient means of obtaining direct current for welding from existing alternating current equipment. It can also be used as a power source for the Argonarc process, provided that HF filters are fitted. The PR 250 can be used in conjunction with most conventional single operator welding sets of 300A maximum capacity and an open circuit range from 80 to 100 volts.

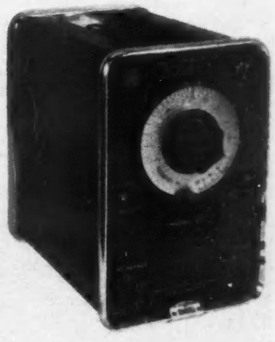
The rectifier is a simple compact unit housed in a weatherproof sheet steel case and mounted on skids. It consists of a naturally air cooled rectifier bank, bridge-connected for full wave rectification and with a smoothing choke to give good arc stability. The silicon rectifier elements are completely sealed from the atmosphere and will not deteriorate in service.

The welding current follows closely that of the alternating current input and is adjusted from the control of the associated a.c. set. The open circuit voltage is approximately 70 to 85 volt depending on the open circuit voltage of the a.c. transformer, and a maximum direct current output of 250 A can be obtained.

No cooling fan is used, there are no moving parts, and connection is made simply by plugging in the two rectifier leads to the output terminals of the a.c. welding set. The unit enables both ferrous and non-ferrous electrodes to be deposited with the minimum of outlay. *Quasi-Arc Limited, 213 Oxford Street, Bilston, Staffs.*

OSCILLATOR

Ultra Low Frequency



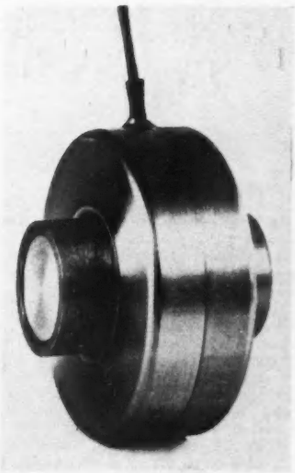
OSCILLATOR type 445 ULF is designed for use at ultra-low frequencies in the range from 0·01 to 1·00 kc/s.

The variation is obtained by resistance-capacitance tuning. A selective amplifier circuit with controlled positive feedback maintains continuous oscillation. The amplifier consists of a phase inverter followed by two integrating stages and is made selective by the use of overall negative feedback. The positive feedback circuit includes a symmetrical diode limiter which will stabilise the amplitude of oscillation within three cycles at all frequencies. The rapid response makes the instrument well suited for investigation into vibration and strain in machines and structures.

Each of the two integrators gives a phase shift of nearly 90° so that a quadrature output is available. On the 0° output the level is continuously variable up to 15V into a minimum load of 10 kilohms with less than 0·5 per cent distortion. The 90° output has distortion less than 1·5 per cent, and phase accuracy of $\pm$ 0·5°. In both cases hum and noise are less than 0·1 per cent. The instrument is portable with a weight of $19\frac{1}{2}$ lb. It measures $8\frac{1}{2}$ in by 13 in by $12\frac{1}{2}$ in high. Consumption is 50W from 110V or 220/250V mains. *Dawe Instruments Limited, 99 Uxbridge Road, London, W5.*

MAGNETIC CLUTCH

Stationary Field



FIVE miniature magnetic clutches have been introduced with transmitting torques from 4·2 to 420 oz-in at speeds up to 20,000 r.p.m.

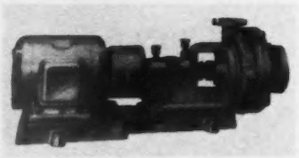
These units can be utilised as clutch-couplings, clutch-brakes and duplex clutches and are intended for the instrument and light engineering fields. Operation is at 24V d.c.

The field section measures 32 mm diameter by 12 mm wide in the smallest model and 80 mm diameter by 30 mm wide in the largest. Of the two hubs, which are 12·4 mm outside diameter in the smallest size, one is fixed solid to the driving shaft and the other keyed to the driven shaft so that it has from 0·008 in to 0·012 in end movement. On energising the field the two hubs are drawn together magnetically and the load engaged.

When used as a brake the stationary hub can be built into the frame or cover of the machine. As combined clutch and brake there are two units with the coil bodies rigidly coupled together in one housing. Power consumption varies from 2 to 11 watts according to size. *Crofts (Engineers) Limited, Bradford 3, Yorkshire.*

CENTRIFUGAL PUMPS

Stainless Steel



DESIGNED for the chemical and food industries is a new range of centrifugal pumps made in stainless steel to avoid corrosion and contamination.

Known as the JTV series, the pumps are supplied in four standard sizes up to a maximum capacity of 425 gallons per minute and a head of 250 ft. Total working pressures, based on the combination of the developed head and the static pressure, range from 90 lb per sq. in to 125 lb per sq. in in the standard models normally kept in stock. Sizes giving greater outputs and pressures are available to order.

All the contact parts on the JTV pumps are made of high grade stainless steel resistant to corrosive liquids. For highly corrosive service the pumps may be fitted with a specially protected gland drip tray.

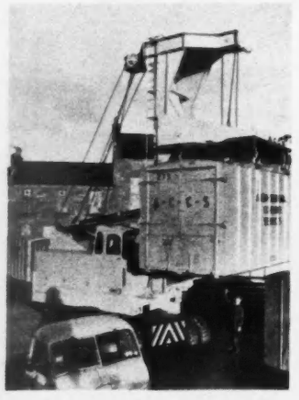
Stainless steel is used in the construction of the body, cover, stuffing box, gland, impeller, shaft, shaft sleeve, and neck rings. The pedestal, bearing cover, and bedplate are made in cast iron. Mating flanges are drilled to BST "C" requirements and unified threads are used throughout the whole of the pump set.

Three basic gland arrangements are available. A sleeve packed gland which may be water cooled if desired, is the first. Second is a single mechanical sleeve for normal duties, and third a single seal of the Fluon type for use in highly corrosive applications.

The pumps are driven by electric motors and these can be standard machines or chosen to suit customers' requirements. The pumps are suitable for brewing and dairy installations as there is no risk of contamination from the materials. The present range of stock sizes is to be extended to include the larger machines now only available to special order. *Holden and Brooke Limited, Sirius Works, Manchester 12.*

MOBILE CRANE

For Handling Containers



A COLES Emperor crane has been developed for the special purpose of handling containers.

The lifting gear includes a mast of rolled steel sections and plates in the form of a hammer head, hinged in support brackets at the lower end. A fabricated steel container carriage projects horizontally from the mast and is raised and lowered by means of a hoist rope that passes over pulleys on the cross piece and is attached centrally to the carriage or frame. Four steel rollers on the carriage run in the main vertical channel of the mast to act as guides, and tilting the mast back slightly lets the container rest against a pad to prevent swinging.

The crane has a short tail radius and the rear is high enough to pass over an empty trailer. Power is supplied by a diesel engine with electric transmission. Separate motors drive the hoist, derrick, slew, and travel motions. Maximum lifting capacity is 12½ tons at a radius of 11 ft 3 in. Audible and visual warnings are given if the safe load is exceeded, and power is cut off. Electromechanical brakes are applied automatically if there is a break in the current, and limit switches prevent hoisting or tilting beyond the safe limit. *Steels Engineering Products Limited, Crown Works, Sunderland.*

OIL PUMP

Topping Up Gearboxes

THE Wanner 328 pump has been designed for the purpose of topping up gearboxes, back axle casings, oil sumps, and the like.

It is a robust unit working on the ordinary syringe principle. The handle has a pistol grip and the nozzle is long and flexible to allow it to be used in very confined spaces. The pump fills by the suction caused when the handle is drawn out and the oil is discharged as the handle is pushed in. The washer on the piston is made of oil resistant material.

The pump cylinder has a capacity of one pint, or 30·5 cu. in. The cylinder is $2\frac{11}{16}$ in diameter and $7\frac{1}{4}$ in long. The overall length including the nozzle is $13\frac{39}{64}$ in. Empty, the pump weighs 2 lb 6½ oz so that it is easy to handle. The flexibility of the nozzle and the comparatively large capacity of the cylinder make it a useful tool for industry in general. *Step Industrial Equipment Limited, Lower Kings Road, Berkhamsted, Hertfordshire.*

DISTRIBUTION BOX

For Oxygen and Fuel Gas

FOR the distribution to torches of oxygen and fuel gas from bulk supplies, multiway, distribution cabinets have been introduced.

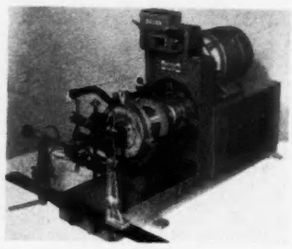
The cabinets are constructed so that up to three burners can operate from the one unit and each unit is fitted with individual non-return valves and flashback arrestors.

Each one is easily portable and they are constructed to give maximum stability against being accidentally knocked over. The operating valves are protected by a guard rail and a carrying handle is fitted at the top.

There are two incoming connections, one for gas and the other for oxygen, and three pairs of outgoing ones, to supply three burners. Their great advantage is the elimination of long trails of hose across the ground from stacks of cylinders to the torches. Tidiness and safety are improved and the risk of loss of gas by a puncture in the hose is reduced. *D. S. Baddeley Engineering Company Limited, 43-45 York Street, Glasgow, C2.*

ARMATURE WINDER

Infinitely Variable Speed



A NEW improved design of the Quickway armature winding machine is now being marketed.

The model 2B incorporates an infinitely variable speed drive from a direct current motor. The supply is obtained from a single phase mains by way of metal rectifiers fitted in the base of the machine. A smooth stepless variation in speed is possible up to the maximum of 1,000 turns per minute according to the application and the size of wire used.

The machine will take armatures measuring up to 2½ in in core length and 3 in core diameter. The range of wire sizes is from 44 s.w.g. to 24 s.w.g. and a wire reel up to 4½ in diameter can be accommodated. The wire is guided into the slots by adjustable fingers. The number of turns to be wound is set on the turns counter; the machine stops automatically when the number is reached. The counter has a hand reset.

To give a smooth stop to the machine a dynamic brake is fitted that is adjustable for rate and gives a constant retarding torque over the whole winding speed range. This ensures that each slot is wound with an identical number of turns.

The machine is equipped with forward and reverse controls, the speed being variable in both directions. On the same panel is the brake adjustment and the main switch. The machine measures 25 in by 18½ in and is designed for bench mounting. It is claimed that the new version cuts down operator time while retaining the principle of winding with the armature stationery. *Midland Dynamo Company Limited, Belgrave Gate, Leicester.*

PAINT GUN

Sprays 1 Pint in 73 Seconds

IT is claimed for the Ecco 40 spray gun that it is capable of spraying 1 pint of paint in 73 seconds with perfect atomisation.

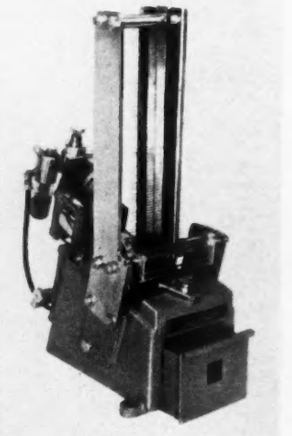
During the trials in which this figure was established, a full wet edge was maintained at both extremities of the paint fan. A car enamel with a viscosity of 22 seconds Ford No. 2 cup was used and air consumption was 25 cu. ft per minute. Another claim for the gun is the small pressure drop between the inlet nipple and the air cap.

As well as the pressure model the gun can be supplied with a range of suction feed nozzles. A high rate of spraying is again achieved. The fluid supply and the fan width can be adjusted with one hand and the gun can be modified for use in the left hand as well as in the right. Two fingers are used to operate the trigger and there is said to be ample room for the remaining fingers between the trigger and the fluid nipple.

Various sizes of air cap, needle, and nozzle can be used in the gun to give it a wide range of general usage. Air consumption can be varied between 25 and 5½ cu. ft per min. The gun will handle a wide range of paints and lacquers as well as higher viscosity materials. *Atlas Copco Limited, Maylands Avenue, Hemel Hempstead, Hertfordshire.*

LEAD FORMER

For Electronic Components



AN automatic machine is now being made for forming the leads of electronic components prior to soldering into circuits.

Made by the Technical Devices Company, the Mark V machine can be operated fully automatically using a mechanical feed chute, or semi automatically with hand feed. In the first case it can handle up to 8,000 units per hour and in the second up to 2,000. Several degrees of automation are available. Operation of the machine is by compressed air, the consumption being 3·4 cu. ft of air per minute when running at 8,000 parts per hour. Air pressure is 40 lb per sq. in. Without accessories the machine weighs 25 lb.

Interchangeable die sets are used to give the various configurations of leads. Jumper wires up to 14 s.w.g. may be cut and formed. The machine is designed primarily for cylindrical components, but flat capacitors or other items with axial leads can be processed. The leads are gripped by pressure fingers prior to cutting and forming, to relieve the component of strain. *Sylvan Ginsbury Limited, 8 West 40th Street, New York 18, NY, USA.*

Lighter Than Air?

A nuclear reactor is probably the worst aircraft prime mover so far devised—with the possible exception of water turbines and animal power. Yet large sums are spent on research and development to put wings on an elephant (white) both in Russia and the United States. Under present peaceful conditions there is nothing a nuclear aircraft can do better than its chemically fuelled counterpart: speed, load carrying capacity, and range (through in-flight refuelling) can be matched blow by blow. As for Mach 3 airliners, where nuclear power might come into its own, they are still a long way from reality. Only when certain—and possibly outdated—military ideas are considered, is there any justification of a nuclear aircraft-engine programme. The dispersal of retaliatory force in a compact and densely populated country might be solved by keeping a number of long-endurance fast aircraft continuously airborne—and continuously taking evasive action against a potential enemy, who would have no trouble at all in spotting the aircraft on his radar screens. Lightness is at a premium in airborne prime movers, with a lighter-than-air engine as the ultimate ideal. A reactor is anything but light, though it might give a new lease of life to the lighter-than-air craft—the airship. The determination to fly a nuclear aircraft can only be understood by referring to the reason why people will climb a mountain. "Because it is there," amended: "and someone else might get there first."

Fissile Missile—Unguided Variety

Nuclear reactors are unsuitable for aeroplane propulsion for several reasons; in fact, endurance is their only saving feature. Apart from a minimum weight of about 30 tons for any sizeable power plant, requiring a very large airframe to support it, two less obvious aspects make the reactor of doubtful value. Like a nuclear ship which must be built to sink safely, that is with an undamaged reactor compartment, the nuclear airliner must be designed to crash safely. But whereas only a small and calculable impact is expected at sea from collisions with other vessels or fixed objects, which the reactor compartment can be built to survive with integrity, the aircraft designer has to contend with forces higher by several orders of magnitude, and is not at liberty to make lavish use of structural reinforcement. In addition, while the ship will sink to the bottom of the ocean, disturbing but a few squid in its passage, the airliner may well crash on top of inhabited or habitable land where physical and radiation damage must be kept to a minimum. Removal of fission-product heat from a core resting on the ocean bottom is not much of a problem, but in air would require large extended surfaces, undamaged by impact, to prevent melting of the containment.

Points of No Return

Control is another problem. A Mach-three airliner will be an expensive piece of machinery and the operator will want to make full use of it. Quick turn-round is one of the essential requirements, and the operator will not look kindly on a waiting time of several hours between trips to allow for the decay in the poisoning effects of fission products. An aircraft engine must also respond quickly to changes in power demand. From zero power during a landing approach the engine must suddenly rise to the maximum potential if the landing attempt has to be abandoned for some reason. Thermal reactors have a notoriously slow response to changes in power demand. In nuclear ships a set of dump-condensers is usually provided, so that during berthing manoeuvres requiring large fluctuations in output the reactor can be operated at constant power and the excess wasted. On an aircraft such a measure is not practicable and probably some auxiliary power in the form of rockets will have to be carried, ready for use at all times. A fast reactor would be less troubled by control response problems, but would require a larger mass of fissile material in the core, and some of the metallic coolants now used would become pyrophoric in contact with air. Fast reactors are not yet fully operational even in land-based stations, and it might be expected that their application to aircraft propulsion will lag behind that of the thermal reactor. If a nuclear reactor performs so poorly in the air, what possible use could it have? Supersonic passenger service and long-range cargo have been suggested as suitable hooks on which to hang the development costs, should the military change its mind about the value of an airborne deterrent.

Marshalling Yard in the Sky

To overcome the disadvantages inherent in a nuclear propulsion system, the *aficionados* of airborne reactors have resorted to some ingenious dodges. All the problems of control response, shielding weight, and ground handling are alleviated in the scheme known as the airborne tug. A nuclear aircraft equipped with split shielding, that is shielding interposed only between the crew and reactor with no shielding in other directions, would circle the globe continuously, changing crew during flight. Conventionally powered cargo planes would rise from airfields, attach themselves to the tug and either receive power through electrical cables or be towed in a long string. When passing airports, some cargo planes would detach themselves and others take their place in a system of airborne shunting. The scheme is practicable as long as the tug does in fact stay in the air, but the unshielded plane would have to be routed carefully to avoid crashing in population centres. Maintenance would be a problem, and the tug would require a conventional power source for the occasional landing and take-off. Special provisions to prevent damage to the crew from back scattering on the ground would also have to be taken.

Around the World in Hasty Days

It is claimed that a nuclear aircraft could fly around the world without refuelling at supersonic speeds. Such a feat, although impressive, is of doubtful commercial value, the number of paying customers interested in such high-power sightseeing being limited to a handful of eccentric tourists. For practical commercial purposes, the longest earth-bound distance that need be considered is half the planet's circumference, or about 12 000 miles. In 1946 a bomber of the US Navy flew that distance without refuelling, although admittedly not at supersonic speed and with zero payload. The trip, if undertaken in a hypothetical Mach 3 airliner, would take roughly six hours, or three times longer than it might take to travel between the population centres and airfields suitable for nuclear-powered aircraft. As the bulk of available passenger traffic would be distributed over shorter distances than the 12,000 mile maximum, the anomaly would be even greater.

Atomic Airships

It is perhaps surprising that in view of all the disadvantages of nuclear aircraft popuIsion, so little is being done about the only airborne transport system that could be built with existing knowledge and equipment. A number of available reactors could be put on board a large airship without much difficulty today, and if a direct-cycle high-temperature reactor is developed driving a set of gas turbines, the power to weight ratio would not be at all unattractive. The airship, if built with several gas compartments filled with helium, could be the safest airborne craft in operation, and would sink to the ground relatively slowly even after severe damage. The control requirements of an airship are similar to a submarine, a dozen of which are now in successful operation using nuclear propulsion. Owing to the large size of an airship it is possible to separate crew and passengers from the reactor compartment by some hundred feet, making split shielding practical. The Goodyear Aircraft Corporation, the only surviving airship makers in the world, have made a design study of a 4½ million cu. ft capacity rigid airship using nuclear propulsion. Length of the ship would be 450 ft, and cruising speed between 90 and 100 miles per hour at a maximum ceiling of 10,000 ft.

Return of the Zeppelin

For passenger service the performance of an airship is unexciting. The chief selling points would be luxurious comfort, quietness of operation (the noise level of the Hindenburg is still unmatched) and lack of pitching and rolling. The illustrations show two views of a nuclear-powered passenger carrier which appeared in the book *The Zeppelin in the Atomic Age*

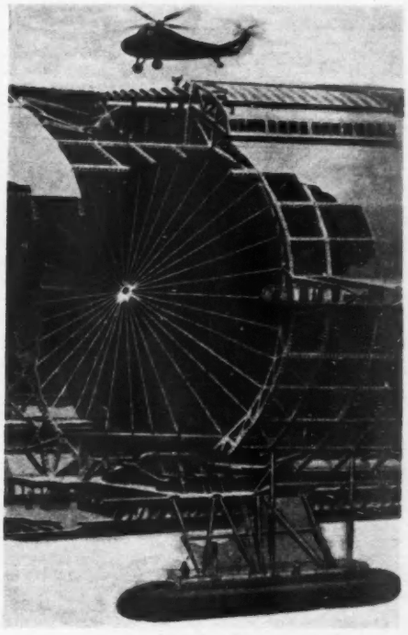


Fig. 2 Helicopter platform for landing crew, passengers, fuel and parts on an airship in flight.

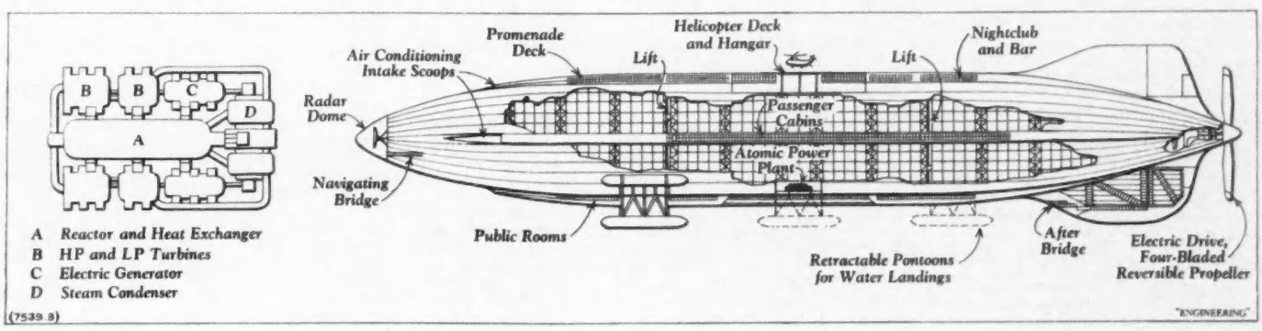


Fig. 1 General arrangement of a nuclear-powered passenger airship with 100 m.p.h. cruising speed.

by E. J. Kirschner, published by the University of Illinois Press. Another application would use the airborne tug principle. A nuclear-powered airship could stay aloft even during maintenance shut-downs, with parts, fuel, equipment and personnel ferried by helicopters. Conventional slow-speed cargo planes or airships could be attached during flight and receive electrical power through cables. Bulk cargo could be carried in this way between landlocked cities at high speed and without the need for trans-shipment—at a cost comparable to that of sea transport.

Nuclear Aircraft Hazards

The Aerospace Nuclear Safety Board is busy drawing up regulations and codes for the operation of nuclear aircraft. In the initial stages at least nuclear aircraft will be carefully confined to air lanes which avoid dense population centres, and special radar monitors will watch for any irregularities in the flight path. Following a crash, under certain conditions it will be preferable if the crew stay in their compartment until a shielded vehicle can be brought in for their removal. The procedure would avoid the danger of exposure to the reactor compartment, the shielding of which may be damaged. Special foams will be developed which would form a sealing layer over a wreckage to act as a barrier to escaping fission products. Rescue and decontamination equipment would have to be highly mobile and deployed along the planned route in advance in order to reach the scene of an accident with the least delay. Flights will only be undertaken when the weather conditions would tend to assist dispersal of radioactive contamination in a direction away from population centres.

American Nuclear Aero-engine Programme

Last August, the position of the nuclear aircraft projects in America were reviewed at an open congressional hearing, where the Air Force, the Navy and interested industries presented their views. The major conclusion drawn from the hearings was that the aircraft programme will be continued at a slightly accelerated pace, but emphasis will be shifted from getting a reactor into the air as quickly as possible to solid development testing on the ground. No decision has been made on the choice between the direct-cycle and the closed-cycle plants, the former developed by General Electric, the latter by Pratt and Whitney. The Blaw-Knox Company have been appointed to submit a report on the facilities required for testing an experimental aircraft reactor. In the direct-cycle field, the emphasis in the future will be on advanced high-temperature fuel elements, and the General Electric X-211 engine will incorporate the latest developments.

Airframes and Materials

Lockheed and Convair have both contributed to the nuclear aircraft programme by undertaking design studies for nuclear bombers, and operating special test reactors. The Martin Company have prepared a design of a seaplane suitable for nuclear propulsion, and Grumman Aircraft have received a research contract to study the effect of radiation on airframe components.

Nuclear Space Propulsion Studies at New Centre

The new Hopkins Laboratory of General Dynamics will be the base for project Orion, a US Defence Department contract for the propulsion of a 1,000-ton space platform by controlled atomic reactions. Other studies at the $10 million laboratory will be closed-cycle gas turbine nuclear ship propulsion plants and many non-nuclear problems in pure and applied science.

Notes and News

Consort for a Modern University

Universities are likeliest customers for a research reactor, and the collaboration of Imperial College and GEC—Simon Carves should ensure that features dear to the buyer's heart are incorporated in the design of a new 10 kW research reactor. The design was prepared under the direction of Professor J. M. Kay of Imperial College, who wanted a reactor to fulfill the needs of his expanding nuclear power department, at present endowed only with an exponential pile. Professor Kay now has the design, but needs £50,000 to get his reactor. In the meantime, GEC—Simon Carves would be only too happy to meet the needs of any other research institution with some money in the till.

Best of Two Reactor Types

The reactor will be named CONSORT after Prince Albert, who daily surveys the happenings at Imperial College from his perch in Kensington Gardens. CONSORT was finally chosen after several people had suffered a nervous breakdown trying to find a meaningful combination of letters, imbued with deep significance, in the ARGONAUT-ZENITH-HORACE tradition. CONSORT is shown in Fig. 3. The advances claimed for this all-British design are an incorporation of the best features of swimming pool and tank reactors in a successful compromise. Swimming pool reactors are simple and highly accessible, but are experimentally less manageable than tank reactors. Tank reactors take less space and the experimental facilities can be located close to the core, but require more complicated coolant circuits and fuel handling machinery. In CONSORT the top shielding is only 10 ft of water, less than in a swimming pool reactor, but an additional concrete shield (1) such as used in tank reactors must be pushed over the core before operation. Fuel handling can be carried out under direct visual observation with a simple mechanical grapple as a result of this compromise, but it is still possible to provide an unshielded reactor face (9) for experimental purposes, protected only by portable concrete blocks (14). The fuel is normally stored in special storage holes (15) provided under the water shield and arranged to prevent accidental criticality. The

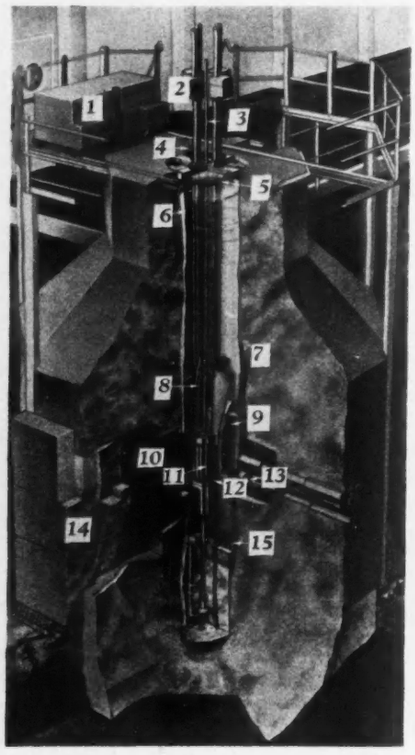


Fig. 3 Consort, a research reactor developed by Imperial College and GEC—Simon Carves.

1 Movable shield
2 Control rod mechanism
3 Experimental tube
4 Pipe duct
5 Dust cover
6 Tank
7 Biological shield
8 Control rod
9 Experimental face
10 Thermal column
11 Fuel elements
12 Support plate
13 Instruments
14 Shielding blocks
15 Shielding plugs for fuel storage holes

grab-head of the handling tool incorporates an interlock, similar in function to the nerve endings in birds' feet, which prevents releasing the fuel element unless its weight is fully supported.

Split Neutron Beam

The reactor core is immersed in an aluminium tank (6), closed only with a perspex dust cover. Twenty four standard MTR fuel elements, used in many research and materials testing reactors, are arranged in a roughly cylindrical pattern over a support plate (12) which permits coolant circulation between the fuel plates. Flat absorber blades are provided, two for shut-down and one for fine control, with a choice of two electromechanical drives, one using rack and pinion, the other wire and spool. Continuous power level is 10 kW, giving a flux of 3×10^{10} thermal neutron and 2×10^{10} fast neutrons per sq. cm per sec. The unshielded reactor face can accommodate experiments close to the core, but outside the water moderator tank. Alternately, a specially designed graphite thermal column (10) can be supplied as an optional extra. By means of a series of voids the neutron flux is modified to optimise flux distribution and strength on a vertical extension of the column. The neutron beam is in effect split, and both the horizontal and vertical portions are available for experiments. One or more horizontal beam-tubes can be incorporated in the design, and a vertical through-hole permits cycling of specimens through the central flux of 4×10^{11} fast and 2×10^{11} thermal neutrons per sq. cm per sec.

Solvent Extraction for Corrosion Resistant Fuel Alloys

Corrosion resistance in water is one of the aims sought in new fuel alloys for pressurised or boiling water reactors. Zirconium alloys have satisfactory corrosion resistance, but pose unexpected problems when the fuel has to be reprocessed. In preparing aqueous nitrate solutions from spent fuel elements in preparation for solvent extraction, serious dissolution problems arise. The dissolution rate of zirconium is impracticably low in nitric acid, some uranium-zirconium or uranium-niobium alloys react explosively with the acid in the absence of fluoride, and the use of reagents containing fluoride for the suppression of explosions gives rise to extremely corrosive mixtures. Studies at Oak Ridge National Laboratory show that hydrofluoric acid with an oxidising agent is a superior dissolver, but attacks all known structural materials. Ammonium fluoride is compatible with austenitic stainless steels and was found to be suitable for the dissolution of Zircaloy-2 fuel cans and zirconium and niobium alloys of uranium. (T. A. Gens: New Developments in Uranium-Zirconium Alloy Fuel Reprocessing, ORNL report CF-59-12-62.)

Martin Nuclear to Fabricate Fuel for Elk River

Fuel elements for the 22 MW(e) Elk River boiling water reactor will be supplied by Martin Nuclear at a cost of $390,000. Each fuel element will consist of 25 stainless-steel tubes over 5 ft long, loaded with ceramic pellets of natural or enriched uranium oxide, and thorium oxide. The tubes will be assembled into 148 bundles, of which 22 will be enriched. Final fuel inventory is expected to be around 480 lb of uranium oxide and nearly five tons of thorium oxide. The Elk River plant, designed and constructed by Allis Chalmers for the USAEA Power Demonstration Program, will go into operation in 1961.

Wire Fuel

A fuel element incorporating a fuel bearing stainless steel wire $\frac{1}{8}$ in diameter wound into a helix is used for a critical experiment at the Idaho Reactor Testing Station. The wire contains 93·2 per cent enriched uranium oxide. The wires not only provide the fuel but are also used as resistance heating coils when it is desired to raise the temperature of the assembly. The fuel elements may be heated to 1,200° F (650° C), while the moderator reaches 1,000° F (540° C) by absorbing reflected heat. Separate heating strips are embedded in the reflector. The facility is not a prototype of a working reactor but was designed as a low-cost experiment to test measuring techniques for high-temperature reactors. (Description of an Elevated-Temperature Critical Experiment Reactor, H. E. Brown, 1959 ANS Winter Meeting, paper 7-9.)

Appointments at GEC

Effective from 1 April, Mr. K. J. Wootton will be general manager, Mr. C. J. O. Garrard deputy general manager, and Dr. H. K. Cameron manager, Atomic Energy Division at the Erith Works of GEC's Engineering Group. The reorganisation follows the appointment of Mr. R. N. Millar as managing director of the Engineering Group.

Reactor Notes

Beachhead at Anzio.—The first boiler of the Latina power station, built for the Nuclear Power Group in Italy, has arrived by sea at Anzio harbour on its way to the Latina site.

Berkeley Relieved.—The second Berkeley pressure vessel has been successfully stress relieved and tested by John Thompson Limited at 211 lb per sq. in.

Assistance for Heavy Water.—The USAEC will assist in the development of heavy-water reactors in Canada with a grant of $5 million, it is reported.

Power in USA.—According to the latest official estimates, nuclear power will be competitive in America by 1968 in areas where coal costs 35 cents per million Btu.

The

'Engineering' Appointments

Section

ENGLISH ELECTRIC

(Whetstone near Leicester)

offer opportunities to

DRAUGHTSMEN

1. **ELECTRICAL** and **MECHANICAL** for work on remotely controlled and automatic machinery for the control and fuelling of Nuclear Power Stations.
2. **PLANT LAYOUT** for work on the layout of Power Station plant and associated reactor plant.

These appointments require applicants to have a Higher National Certificate and several years D.O. experience (preferably in a similar field, but this is not essential). Candidates with O.N.C. and particularly relevant experience would be considered.

The Company offers good working conditions in rural surroundings. The appointments are permanent and pensionable and assistance towards housing can be considered.

In replying please give details of experience, qualifications and current salary. Correspondence should be addressed to **DEPT. C.P.S., MARCONI HOUSE, 336/7, STRAND, LONDON, W.C.2,** quoting reference EG 1899K.

B 449

COLLEGE OF ADVANCED TECHNOLOGY

BIRMINGHAM

Applications are invited for the following posts:
SENIOR LECTURER AND LECTURER IN PRODUCTION ENGINEERING

Applicants should be well qualified technically and professionally and have held a responsible position regarding some aspects of production engineering technology in industry. Experience in development work and experimentation is desirable with ability to develop subjects such as Machine Tools, Metrology and Tool Engineering and other production engineering technology to high level.

LECTURERS IN MECHANICAL ENGINEERING ranging over the subject of Applied Mechanics, Strength of Materials, Mechanics of Fluids, Thermodynamics, Mechanics of Machines or Machine Drawing and Design. Candidates should have an honours degree or equivalent, teaching, industrial and/or research experience.

SENIOR LECTURER IN SOIL MECHANICS

Applicants should offer a high academic qualification with suitable professional and/or research experience.

LECTURER IN CIVIL ENGINEERING

Applicants should offer a graduate qualification and/or membership of an appropriate professional institution with suitable professional experience.

Salary Scales:
SENIOR LECTURERS (Men) £1550-£1750.
LECTURERS (Men) £1370-£1550.

Further particulars and forms of application from the Registrar, College of Advanced Technology, Gosta Green, Birmingham, 4. Applications to be received within 14 days of this advertisement.

K. R. PILLING,
CLERK TO THE GOVERNORS. B 466

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733-£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the INDUSTRIAL RELATIONS OFFICER, WEST MIDLANDS GAS BOARD, 6, AUGUSTUS ROAD, EDGBASTON, BIRMINGHAM, 15. G 848

SENIOR LECTURER

OR

LECTURER

R.N. COLLEGE, GREENWICH, LONDON, S.E.10. Post for SENIOR LECTURER or LECTURER in (*a*) APPLIED MECHANICS and (*b*) PHYSICS AND ELECTRICAL ENGINEERING available in May, 1960, but exceptionally could be held open until September, 1960. Candidates (male) must be British and possess an appropriate Honours degree before appointment (Undergraduates in their final year may apply).

Duties include lecturing and conducting laboratory work to degree standard and post-graduate teaching. Excellent research facilities. Appointments as Senior Lecturer (£1233-£1460), or Lecturer (£655-£1150) according to age, qualifications and experience. Starting salary above minimum may be authorised. Posts carry F.S.S.U. benefits. Single accommodation available.

Particulars and application forms from DIRECTOR OF STUDIES, R.N. COLLEGE, GREENWICH, LONDON, S.E.10. Closing date for applications 15th March, 1960. B 478

SHEFFIELD CORPORATION

WATERWORKS

YORKSHIRE DERWENT SCHEME

Applications are invited for the following appointments on the staff of the Waterworks General Manager and Engineer (A. B. Baldwin, M.Eng.):—

TWO CHIEF ASSISTANT ENGINEERS I/c Sub-sections, J.N.C. Scale "A" salary £1215 to £1445.

Successful applicants will be engaged upon the design and construction of the works of the Yorkshire Derwent Scheme, comprising a river intake and treatment plant, a 40 mile aqueduct, service reservoirs, pumping stations and plant.

Applicants must be Chartered Engineers experienced in the design and construction of major works and previous employment on similar water supply schemes would be an advantage.

Appointments are superannuable and subject to medical examination and to the national conditions of service as applied by the City Council.

Applications, stating age, qualifications, present and past appointments (with dates and salaries), details of relevant experience and schemes engaged upon and quoting the names and addresses of two referees should reach the undersigned not later than the 12th March, 1960.

JOHN HEYS,
TOWN CLERK.

TOWN HALL,
SHEFFIELD, 1. B 430

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1.

Applications are invited for appointments as

LECTURER and SENIOR LECTURER

in the Department of CIVIL and MECHANICAL ENGINEERING, dating from September, 1960, or earlier, in regard to the following subjects:—**MECHANICS OF MACHINES, APPLIED THERMODYNAMICS, STRENGTH** and **PROPERTIES OF MATERIALS, MECHANICS OF FLUIDS.**

Applicants should be qualified to teach in courses for the Engineering Degree and Diploma in Technology and for Senior Lectureships should be able to make some contribution at post-graduate level in teaching or taking charge of research projects. Facilities are available for research by members of staff. These appointments are additional to the present staff and arise from the rapid growth in the work of the College.

Salary scales: Lecturer, £1370 rising to £1550; Senior Lecturer, £1550 rising to £1750; plus in each case London Allowance of £38 rising to £51 at age 37.

Further particulars and forms of application are obtainable from the SECRETARY, to whom applications should be sent by 21st March, 1960. B 438

NORTHERN ELECTRIC CO.—CANADA

OFFERS

JOB SECURITY

TO

CABLE ENGINEERS

In over 20 years no engineer has been laid off in this expanding Canadian Company which now requires additional qualified Engineers and scientists for its Wire and Cable Design Laboratory and Cable Plant Engineering Departments.

Communications cables, rubber and plastic power cables, and paper insulated cables for low and extra high voltages are designed and manufactured in a modern plant located in Montreal and possessing excellent laboratory facilities.

Interviews will be held in convenient centres in Great Britain during late March. Transportation allowance for successful applicants. All inquiries treated in confidence and acknowledged. Give full details of qualifications, experience, etc., in first letter to:

Dept. N.E.C.

National Employment Service—Canada

61 Green Street, London, W.1

B442

MECHANICAL ENGINEER

A large national Company has a vacancy for a Mechanical Engineer in each of the following centres:

Newcastle
Glasgow
Manchester
Wolverhampton

The Company is an expanding one and future prospects are very bright. The need is for good calibre men aged 28/30 with experience in the heavy engineering or chemical fields. Candidates should preferably have at least a H.N.C. in Mechanical Engineering, or M.O.T. 1st Class Certificate (Steam and Diesel) supported by an engineering apprenticeship. Please send brief details to BOX B 461, Offices of ENGINEERING.

INSTRUCTOR BRANCH, ROYAL NAVY

Applications are now invited for SHORT SERVICE COMMISSIONS in the Instructor Branch of the Royal Navy. The primary requirement is for men of good personal qualities with degrees (or the equivalent) in Mathematics, Physics or Engineering, but graduates in Chemistry, Metallurgy, History, Geography or English will also be considered. An additional requirement exists for non-graduates with teaching qualifications.

Service in the Instructor Branch combines all the advantages of life in the Royal Navy—e.g., comradeship, travel, a wide variety of cultural and sporting activities, a high standard of living, responsibility, etc.—with the opportunity to utilise scientific, technological and professional qualifications at all levels.

The work of the Instructor Officer is fundamental to the Fleet and covers the widest field of operational, technical and academic duties ashore and afloat, ranging from basic instruction to work on the latest developments in nuclear power and guided weapons. Instructor Officers are also the meteorologists of the Royal Navy.

Note also:—

- Students in their final year may apply.
- Short Service Commissions are granted initially for 3, 4 or 5 years and may be extended up to 12 years.
- £465 tax free gratuity after a Short Service Commission of 3 years, and pro rata for longer.
- Starting pay is £584 p.a., rising to £693 p.a. after 1 year's service (£693 p.a. rising to £910 p.a. for 1st and 2nd Class Honours Graduates). This is augmented where appropriate by generous allowances, so that at the age of 30, a married Honours graduate could earn about £1800.
- Service in the Instructor Branch qualifies for Burnham Scale increments, and may be recognised for the purposes of the Teachers' Superannuation Acts.
- Short Service Officers may apply for Permanent Commissions.
- Candidates must be British subjects, sons of British subjects, under 36 years old, and medically fit.

For further details apply to:—

DIRECTOR, NAVAL EDUCATION SERVICE (P/14),
ADMIRALTY,
LONDON, S.W.1. B 446

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON—STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days leave per year initially.

Salary for Grade III ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, qualifications and experience. Also vacancies in higher grade for suitably qualified candidates on range from £895 to £1055 p.a. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.C.1., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3745) giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 842

RESEARCH CHEMIST

ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM, BERKS., requires RESEARCH CHEMIST for two-year research programme in study of modification of organic materials by electrical discharges. Duties include design and construction of vacuum systems, preparing samples for test and analysis of products. Appointment as Scientific Officer, Experimental Officer or Asst. Experimental Officer with salary up to £1090 (S.O.), £1166 (E.O.) or £830 (A.E.O.) grading and starting pay according to age and quals. Qualifications required: S.O.—2nd Cl. Hons. degree; E.O. and A.E.O.—G.C.E. at "A" level in two or more subjects or H.N.C. or equiv. Quarters available for single man; possibility of house for married man. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting reference F.106/OA. Closing date 18th March, 1960. B 479

MECHANICAL AND ELECTRICAL ENGINEERS

Pensionable posts for men and women normally under 35 on 1.3.60. Applicants must normally have degree in engineering or physics (or Dip. Tech. for some posts) or have passed examinations necessary for A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.Soc., etc. Exceptionally, evidence of high professional attainment acceptable in lieu. Practical training and experience required but untrained graduates acceptable for some posts. Men's starting salary (London) from £830 (lower if under 25) to £1125. Maximum £1300. Promotion prospects. Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S 85/60. Closing date 30th March, 1960. Earlier applicants may be interviewed before that date. B 480

DESIGN ENGINEER

required by the UNITED KINGDOM ATOMIC ENERGY AUTHORITY at Dounreay Experimental Reactor Establishment, Thurso, Caithness, Scotland, to head a small team engaged in the design of mechanical plant associated with chemical processing and experimental laboratory work; to collaborate with scientists engaged on experimental work; to deal with modifications to existing plant, and to provide liaison with a headquarters' design organisation engaged on major projects.

Applicants must have served a recognised engineering apprenticeship and be corporate members of the Institute of Mechanical Engineers or have equivalent qualifications. Wide experience of design office management and experience in chemical plant and mechanical equipment design are essential.

Salaries will be assessed, according to age, qualifications and experience within the range £1370-£1825. Contributory Superannuation. Staff housing scheme. Hostel accommodation available.

Send postcard for application form, quoting reference 181/J2 to PERSONNEL MANAGER at above address.

Closing Date: 14th March, 1960. B 447

ROYAL TECHNICAL COLLEGE, SALFORD
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the following academic appointments in this COLLEGE OF ADVANCED TECHNOLOGY:—

SENIOR LECTURER in Applied Thermodynamics.
SENIOR LECTURER in Fluid Mechanics.
SENIOR LECTURER in Mechanics of Machines.
SENIOR LECTURER in Strengths of Materials.
SENIOR LECTURER in Production Technology.
LECTURER in Mechanical Engineering.

Applicants should have an honours degree in engineering or applied science, or an equivalent qualification, and industrial, research or teaching experience in the appropriate subject.

Each person appointed will be expected to take a leading part in the Department in the teaching of his subject, at least up to honours degree level; in appropriate cases he will be expected to carry out research in it. Staff may also undertake private consulting work subject to reasonable safeguards.

Salary scales are as follows:—

Senior Lecturer: £1550 rising to £1750 per annum.
Lecturer: £1370 rising to £1550 per annum.

Appointments may be made at appropriate points within these scales, up to their maxima, depending on the candidate's experience. Exceptional applicants for a Senior Lectureship may be considered for appointment as a PRINCIPAL LECTURER in the salary range £1750 rising to £1900 per annum.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD, 5, LANCS., to whom applications should be sent by Monday, 4th April, 1960.

R. RIBBLESDALE THORNTON,
CLERK TO THE GOVERNORS. B 488

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

(In affiliation with the University of Glasgow)
DEPARTMENT OF MECHANICAL ENGINEERING.
CIVIL AND CHEMICAL
LECTURER
IN
STRENGTH OF MATERIALS

Applicants should possess Honours degree in Engineering or Applied Mathematics, an interest in elasticity and stress analysis techniques, an experience in the use of photoelastic techniques an advantage. Excellent research facilities for a higher degree.

Salary on scale £900 by £50 to £1350 by £75 to £1650 plus F.S.S.U. and Family Allowances.

Application forms obtainable from the SECRETARY, GEORGE STREET, C.1. B 484

THE COLLEGE OF AERONAUTICS

Applications are invited for the PERRING SCHOLARSHIP IN AERONAUTICS, valued at £500 per annum, tenable at The College of Aeronautics. The successful candidate will be admitted to the two-year course in Aeronautical Engineering and Science at the College, leading to the award of the College Diploma (D.C.Ae.).

Applicants should preferably be Honours graduates or final year under graduates in engineering, mathematics or physics; applications from non-graduates with comparable qualifications will also be considered. Candidates must be British subjects domiciled in the United Kingdom.

Forms of application and statement of conditions will be forwarded on written application to:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS.

The closing date for the receipt of applications is 18th May, 1960. B 486

BATTERSEA COLLEGE OF TECHNOLOGY

LONDON, S.W.11.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Applications are invited for Graduates of a British University for GRADE B LECTURESHIPS in Civil or Mechanical Engineering. Adequate facilities provided for doing research. The salary for a good honours graduate with 2 years' experience would be within the range £988 by £27 10s. 0d. to £1396. Further particulars from the CLERK TO THE GOVERNING BODY. The closing date for applications is 31st March, 1960. B 498

THE UNIVERSITY OF LEEDS

DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for two LECTURESHIPS in CIVIL ENGINEERING, at salaries on the scale £900 by £50 to £1350 (efficiency bar) by £75 to £1650 a year. Candidates should have had some practical experience and preference will be given to those with a special interest in at least one of the following subjects: Hydraulics, Surveying, Heating and Ventilation, Steelwork Design. Applications (three copies) stating date of birth, qualifications and experience, together with the names of three referees, should reach the REGISTRAR, THE UNIVERSITY, LEEDS, 2 (from whom further particulars may be obtained) not later than 1st April, 1960. B 346

THE UNIVERSITY OF LEEDS

DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for appointment as LECTURER in the Department of Electrical Engineering. Candidates should have good academic qualifications and experience in the field of electric power engineering, preferably electrical machines. Salary will be on the scale £900 by £50 to £1350 (efficiency bar) by £75 to £1650 a year. Applications (three copies) stating date of birth, qualifications and experience together with the names of three referees should reach the REGISTRAR, THE UNIVERSITY, LEEDS, 2 (from whom further particulars may be obtained) not later than 4th April, 1960. B 495

THE SCHOOL OF ENGINEERING

KUMASI COLLEGE OF TECHNOLOGY, GHANA

Under a rapidly developing expansion programme, the College invites applications for the following posts:

CIVIL ENGINEERING.
SENIOR LECTURERS AND LECTURERS IN—
(*a*) Hydraulics.
(*b*) Engineering Structures.
(*c*) Soil Mechanics.
(*d*) Properties of Materials.
(*e*) Land Surveying.

MECHANICAL ENGINEERING.
THE HEAD OF DEPARTMENT
SENIOR LECTURER IN STRENGTH OF MATERIALS

LECTURERS IN—
(*a*) Strength of Materials.
(*b*) Theory of Machines.
(*c*) Engineering Drawing.

ELECTRICAL ENGINEERING.
SENIOR LECTURERS OR LECTURERS IN—
(*a*) Generation and Distribution.
(*b*) Telecommunications.

A good degree in Engineering is necessary for all posts, except the Lectureship in Surveying for which the Professional Associate of the Royal Institution of Chartered Surveyors is acceptable. Post-graduate industrial and/or teaching experience is essential for all posts.

Contract appointments are normally for five years, and may be renewed. Three months' notice of resignation of an appointment is required.

The Contract Salary Scales are:
Head of Department: £3430 by £112 10s. 0d. to £3767 10s. 0d. p.a.
Senior Lecturer: £2370 by £90 to £2910 p.a.
Lecturer Grade A: £1987 10s. 0d. by £75 to £2437 10s. 0d. p.a.

A gratuity at the rate of £150 a year is payable at the end of a contract period. Children's allowances are paid up to a maximum of three.

The School is recognised by London University for the B.Sc. (Engineering) Degree, and the first group of students graduated in 1959. Courses are also conducted for the examinations of the Royal Institution of Chartered Surveyors.

The School of Engineering has very well-equipped laboratories and workshops, besides the usual staff rooms, lecture rooms and drawing offices. Ample facilities for research are available.

The College is fully residential, and members of staff are housed in pleasant, modern bungalows on the spacious campus; climate and living conditions are good.

Application forms and an Information Brochure may be obtained from the ASSISTANT REGISTRAR, REFERENCE E/E/1, KUMASI COLLEGE OF TECHNOLOGY, 29 TAVISTOCK SQUARE, LONDON, W.C.1, who will also be glad to answer any questions about these appointments. The Principal of the College will be in London to interview candidates for these posts in April. B 487

AIC

ENGINEERS
(Consultants)

Executive Selection Service *is advising on the following appointment*

Associated Industrial Consultants Limited require engineers between 28 and 38 years of age for work in the United Kingdom, British Commonwealth and Europe. A University degree or equivalent qualification is essential. In addition, experience of at least five years in a managerial capacity is required. Selected applicants will be trained at the Company's College of Management and the posts carry an initial salary of approximately £1700 per annum with opportunity for regular increases to £2700. In addition there are superannuation contributions and expense reimbursements by the Company and opportunities for promotion to senior positions with considerable advancement of salary. Special consideration will be given to those wishing to reside in Ireland and Scotland, and to those who are fluent in French, German or Italian.

All applications will be treated in confidence.

A brief statement of qualifications and experience should be sent to the Personnel Secretary, marked (E) 422/2, at

Associated Industrial Consultants Ltd BUSH HOUSE LONDON WC2

B 474

THE COLLEGE OF AERONAUTICS

ENGLISH ELECTRIC RESEARCH FELLOWSHIP IN AERONAUTICS

Applications are invited for a Research Fellowship which has been established at the College by the English Electric Company Limited. The Fellowship is intended to provide opportunity for post-graduate research into the problems of vibration or stability and control of aircraft and is tenable for one year beginning on or about 1st October, 1960. The value of the Fellowship is £750.

Applications giving full particulars of education and experience and quoting the names of three referees are required by 1st May, 1960, and should be addressed to:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS. B 485

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1.1.60 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. Starting salary (men, London) from £830 to £1125 according to age. Scale maximum (London) £1300. Promotion prospects.—Write CIVIL SERVICE COMMISSION, 17, NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting S/64/8. B 496

BATTERSEA COLLEGE OF TECHNOLOGY

LONDON, S.W.11.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

Applications are invited for the post of SENIOR LECTURER in Mechanical Engineering. Candidates should have a good honours degree and some experience of teaching and research in Engineering Science. Industrial or other professional experience is also desirable. The salary will be within the scale £1588 by £50 to £1801.—Further particulars from the CLERK TO THE GOVERNING BODY. The closing date for applications is 31st March, 1960. B 497

APPOINTMENTS OPEN

ASSISTANT CHIEF ENGINEER

THE MAKERS OF HOLLANDS TOFFEE require an ASSISTANT CHIEF ENGINEER. Applicants, aged 28-40, must hold either Corporate Membership of the Institution of Mechanical Engineers or an engineering degree, and should preferably have served a recognised engineering apprenticeship or its equivalent. They must have a wide engineering experience, including installation and maintenance of factory plant and services, and a knowledge of steam-raising plant and electrical services. The duties of the post also embrace design and manufacture of special-purpose equipment and experience in this field will accordingly be an advantage. The person appointed will be responsible to the Chief Engineer (for whom he will be expected to deputise when necessary) and will find the work arduous but rewarding. A commencing salary in the £1200-£1400 range is envisaged.

Write for application form to PERSONNEL MANAGER, ARTHUR HOLLAND, SOUTHPORT, LANCS. B 482

Pfizer

Senior Draughtsman

As a result of planned expansion and subsequent promotion from within the Company, there is a vacancy in the Drawing Office for a Senior Draughtsman. Applicants must have completed a recognised engineering apprenticeship, possess at least an O.N.C. in Mechanical Engineering and be aged between 25/35.

Additionally several years first class experience in the design and layout of Chemical and Pharmaceutical plant, equipment and services will have been gained. A knowledge of Civil Engineering practices would be advantageous.

The Company's offices are situated at Sandwich, Kent, and offer a wide choice of residence in coastal or rural districts. There are travel assisted schemes to and from the principal areas of residence.

A generous non-contributory Pension and Life Assurance scheme is operated, removal expenses paid and assistance may be given with housing.

Applications stating age, experience and qualifications should be sent to the—

Personnel Officer, Pfizer Ltd., Sandwich, Kent B 450

THE PFIZER GROUP

ASSISTANT WORKS MANAGER

The Works Manager of a progressive Light Engineering Company in the London area is seeking to appoint a qualified assistant to relieve him of some of the day to day problems of batch production.

The ideal person will be in his mid-thirties and should have had some years' experience in shop management. His earlier background should include sound practical and theoretical engineering training, with a toolroom apprenticeship preferred. He must possess drive and enthusiasm and be capable of giving a sound technical lead to production and maintenance foremen.

A good salary is offered and the position is pensionable and offers excellent prospects. Please write full details of age, experience, etc., in confidence, to BOX B 451, Offices of ENGINEERING.

THE UNIVERSITY OF MANCHESTER

POST-GRADUATE NUCLEAR ENGINEERING COURSE

The seventh
POST-GRADUATE NUCLEAR ENGINEERING COURSE
will be held in the Engineering Department of the Faculty of Science from May 30 to July 8, 1960 (inclusive). The Course is intended for Science and Engineering Graduates and is of post-graduate standard. Applications for entry should be sent as soon as possible to

The Director,
Extra-Mural Department,
The University, Manchester, 13,

from whom full details and application forms may be obtained.

B 443

CIBA LABORATORIES LIMITED

require

MECHANICAL AND ELECTRICAL ENGINEERS

Initially the Candidates will be required to assist in the planning lay-out and erection of chemical plants. This will last for approximately two years, after which the Mechanical Engineer should be capable of becoming a Deputy Chief Engineer and the Electrical Engineer, capable of assuming responsibility as Deputy Works Electrical Engineer.

Candidates should be graduates or equivalent, aged 25-45.

Salary will be in accordance with experience and qualifications.

Applications should be addressed to:

THE CHIEF ENGINEER,
CIBA LABORATORIES LIMITED,
PYEWIPE,
GRIMSBY.

B 499

AIR PRODUCTS (G.B.) LTD.

have vacancies for

PROJECT MANAGER

A qualified Chemical or Mechanical Engineer with experience as Project Engineer in the chemical plant field. Experience in low temperature engineering is desirable but not essential.

DEVELOPMENT ENGINEER

A qualified Chemical or Mechanical Engineer for appraisal of new techniques equipment design, the study of materials and preparation of standards, etc.—all associated with the design construction and operation of low temperature plants.

STANDARDS ENGINEER

H.N.C. (Mech.) minimum, with experience as a Standards Engineer in the Chemical and Process Plant Industry. To originate and prepare engineering standards for use in the Design Department and other engineering facilities of the Company on request, and to develop these standards into a comprehensive manual on his own initiative. Must be able to develop fully design standards for all aspects of pressure vessel, piping and mechanical design for ferrous and non-ferrous applications. Experience of high pressure and high temperature systems is advantageous, together with a knowledge of valves and flange systems. Must possess leadership potential to develop a fully integrated Standards Group.

Write

PERSONNEL MANAGER
49-50, POLAND STREET,
LONDON, W.1.

B 490

BRITISH INSULATED CALLENDER'S CONSTRUCTION CO., LTD.

have vacancies in their Overhead Line Contracts Department in London for:

ASSISTANT DESIGN ENGINEERS

Work involves structural design aspects of Electrical Transmission and Distribution Lines. Previous experience desirable, although not essential but structural background up to H.N.C. standard an advantage. After appropriate training successful applicants will be expected to conduct technical correspondence and negotiations. These posts carry progressive responsibility.

Attractive salaries will be offered to suitable applicants. Pension Fund, Staff Canteen, Five-day week.

Apply in writing stating full details to Staff Officer, above Company, at 30, Leicester Square, London, W.C.2.

B 464

ASSISTANT ENGINEER

REGENT OIL COMPANY LIMITED require ASSISTANT ENGINEER at their Bristol Office for work in connection with the maintenance and development of Oil Distributing Depots in the West of England and South Wales.

Qualifications required H.N.C. in Mechanica Engineering or Grad.I.Mech.E.

Age 25-30 years. Previous experience in Oil Industry preferable but not essential.

Salary in accordance with experience and background.

Life Assurance and contributory Pension Fund.

Details of education, technical qualifications and career in confidence to STAFF RELATIONS OFFICER, REGENT OIL COMPANY LIMITED, PRUDENTIAL BUILDINGS, WINE STREET, BRISTOL, 1.

B 413

ENGINEERING DRAUGHTSMEN AND ENGINEERS

ALL GRADES OF ENGINEERING DRAUGHTSMEN AND ENGINEERS required immediately. High starting salary.—Please Phone AMB 8189.

B 424

THE CHESTERFIELD TUBE COMPANY LIMITED

makers of Steel Gas Cylinders, Hot and Cold Drawn Tubes, Extruded Tubes and Sections are creating the post of

SENIOR METHODS ENGINEER

Applicants should be in the age group 28-40, and should have at least H.N.C. or equivalent qualifications. Experience of modern Production Engineering methods, payment by results systems and Production Control techniques is essential. This post will carry considerable responsibility and offers good scope for a man with energy and initiative. It will carry with it the benefits of a contributory pensions scheme and a five-day week.

Applications, giving full details of Education, Experience and Salary required, should be addressed to

THE SECRETARY,
THE CHESTERFIELD TUBE COMPANY LIMITED,
CHESTERFIELD

B 470

JOHN LAING & SON LIMITED

require an

ASSISTANT MECHANICAL or ELECTRICAL ENGINEER

in the Design Office at their Headquarters.

Applicants should be Associate Members or Graduates of their appropriate institution and have design experience in Mechanical and Electrical Services to buildings.

The post is permanent and progressive. Five-day week. Superannuation scheme. Apply stating age, qualifications and experience to **PERSONNEL MANAGER (M.E.S.4), JOHN LAING & SON, LIMITED, PAGE STREET, LONDON, N.W.7.**

B 462

SENIOR MECHANICAL ESTIMATOR

SENIOR MECHANICAL ESTIMATOR required for a responsible position in a Company engaged on the development and manufacture of specialised engineering equipment. He must be capable of preparing full estimates or accurate appraisals on light/medium mechanical and electronic equipment, and must have previous experience of sales and production estimating. A first class salary will be paid and the conditions of employment are excellent.

Please apply in confidence to THE REGIONAL PERSONNEL MANAGER, PLESSEY NUCLEONICS, LTD., WEEDON ROAD, NORTHAMPTON.

B 472

ASSISTANT CHIEF ENGINEER

THE HARPER PAPER GROUP, a rapidly expanding group of companies engaged in paper making, converting and merchanting, requires an ASSISTANT CHIEF ENGINEER for employment in the Blackburn area. Applicants, aged 28-40, must hold either Corporate Membership of the Institution of Mechanical Engineers or an engineering degree, and should preferably have served a recognised engineering apprenticeship in installation and maintenance of modern machinery and plant used in the industry and a knowledge of steam-raising plant and electrical services. The person appointed will be responsible to the Chief Engineer (who is an Executive Director of the Group) and will find the work arduous but rewarding. A commencing salary in the £1200-£1400 range is envisaged.

Applications in first instance to THE HARPER PAPER GROUP LIMITED, SOUTHPORT, LANCS.

B 483

MECHANICAL INSPECTING ENGINEERS

MECHANICAL INSPECTING ENGINEERS with the necessary technical, manufacturing and operational experience required to deal with the inspection and test of Turbo-alternators, Boilers and Ancillary Power Plant during all stages of manufacture from raw material to finished product. Training will be given to suitable applicants. Salary dependent on qualifications.—Applications to MERZ & McLELLAN, CARLIOL HOUSE, NEWCASTLE UPON TYNE, 1. Reference "HEW."

B 471

TECHNICAL ENGINEERING WRITER

is required by a large firm of component manufactuers in the Midlands dealing with the Automobile, Aircraft and General Engineering Industries. Must be a qualified engineer with journalistic experience, capable of producing technical descriptions of products and installations from information acquired direct from Drawing and Design Offices.

Applications in writing stating age, experience qualifications and salary to BOX B 476, Offices of ENGINEERING.

Our Staff have already been notified of this vacancy.

DESIGN ENGINEER

required with experience of Charging and Defuelling Equipment. Fuel Element handling and shielding in connection with Nuclear Projects.

Applicants with an Engineering Degree will be preferred and full particulars stating age, qualifications and past experience should be sent to:

N.P.E.,
VICKERS-ARMSTRONGS (ENGINEERS) LIMITED,
NAVAL CONSTRUCTION WORKS,
BARROW-IN-FURNESS, LANCS.

B 473

TOOL AND MACHINE TOOLMAKERS

required for Methods Development workshop of large scale light engineering Organisation in North West London. Applicants should have experience in the manufacture and tryout of special purpose equipment associated with the production of components and automatic assembly in the field of instruments and light mechanism.

Applications will be treated in strict confidence and should be addressed to BOX TA 1939, A.K. ADVERTISING, 212a, SHAFTESBURY AVENUE, LONDON, W.C.2.

B 448

DESIGN DRAUGHTSMAN

PUMP DESIGN. Well-known Manufacturers with London location require young but experienced Design Draughtsman for developing range of centrifugal pumps. Post offers scope and opportunity with an expanding organization. Salary in accordance with capacity.—Write BOX B 453, Offices of ENGINEERING.

DRAUGHTSMEN

DRAUGHTSMEN required for design and development work on pneumatic and electric portable power tools. Interesting work, progressive and permanent positions. N.W. London area. State age, experience and salary required to Head Designer, BOX B 452, Offices of ENGINEERING.

The world's leading inventors and manufacturers of special-purpose precision machinery for the Tobacco Industry have opening in their London Drawing Office for:—

MECHANICAL DESIGNER

Applicant should be qualified Engineer, age 25-35, of sound practical experience and with original and inventive mind, receiving recognition in his present post on that account.

This opportunity is permanent and progressive and holds promise of absorbing work on most attractive terms.

Applications stating age, qualifications and experience, should be personally addressed in confidence to G. B. SALMON,

MOLINS MACHINE COMPANY LTD. · Evelyn Street · London, S.E.8

B 477

RESIDENT CIVIL ENGINEERS

Applications are invited for the undermentioned posts for the construction of a power station in the Middle East, commencing summer 1960:—

(1) RESIDENT CIVIL ENGINEER, salary £2500-£2750 p.a.
(2) TWO ASSISTANT R.E.s (CIVIL), salaries £1800-£2000 p.a.
(3) CLERK OF WORKS (CIVIL), salary £1500-£1750 p.a.

Approx. 2-year contracts; first class passages including wife and three children; free furnished quarters; free medical/dental treatment; free insurance; no local Income Tax. Applications with usual details also religion and two referees to WILTON & BELL, CONSULTING ENGINEERS, ROMAN HOUSE, CRIPPLEGATE BUILDINGS, LONDON, E.C.2.

B 501

JUNIOR DRAUGHTSMEN

JUNIOR DRAUGHTSMEN, Croydon. Applicants should preferably have had general engineering training, some workshop practice an advantage. Salary age 16-20—£263-£367 p.a. according to age, age 21 and over within ranges £451-£615 or £491-£650 per annum according to qualifications and experience. Apply in writing, quoting reference V15/1187, to PERSONNEL MANAGER, SOUTH EASTERN GAS BOARD, KATHARINE STREET, CROYDON, within 7 days.

B 493

'ENGLISH ELECTRIC'

AVIATION LIMITED

AIRCRAFT DIVISION - LYTHAM ST. ANNES

Now is the time to secure your future in the NEW AIRCRAFT INDUSTRY with responsibilities in developing the new generation of Civil Aircraft backed by extensive Military Contracts, including considerable development of the Lightning and the new T.S.R.2. There is probably a post with increased responsibilities for you in one of the following categories:—

MECHANICAL ENGINEERS

- Structural Design, Stress Analysis, Airworthiness.
- Internal Flow and heat transfer.
- Development of mechanical systems.
- Aeroelasticity.
- Development Engineers.
- Weight Control Engineers.

AERODYNAMICISTS & MATHEMATICIANS

- Flight Test Engineers with a minimum qualification to H.N.C. level.
- Computer Programmers.
- Aerodynamicists for control stability and performance calculations.
- Fluid flow specialists.
- High speed wind tunnel engineers.

ELECTRICAL ENGINEERS

- Theoretical Design of aircraft electrical systems.
- Development of electrical components.
- Development of Automatic Flight Systems.
- Electronic Engineers for development of "one off" control systems.
- Electrical and Electronic technicians to operate comprehensive test rigs.

AIRCRAFT DESIGN DRAUGHTSMEN

For these vacancies applicants must have 3 years' experience in an aircraft D.O. and be engaged on design work.

- Electrical installations.
- Engine equipment and control installations.
- Structural Design and engine installation.
- Power controls.
- Mechanical design, e.g. undercarriage design, control boxes, escape facilities
- Flight test instrumentation.

If you are interested in one of these subjects and would like to make an appointment to discuss these opportunities on an informal basis, we invite you to write in confidence to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference EG 1716C, giving details of your qualifications and experience and indicating your particular interest.

Appointments will be arranged by the Aircraft Division to suit your convenience, and we will endeavour to meet you at a centre within easy access to your home.

All appointments will be permanent and pensionable, after a qualifying period, and assistance with removals and housing will be given in certain cases.

B468

CHEMICO

Have vacancies for DESIGN & DRAFTING personnel soundly experienced in any of the following fields: —

DESIGNERS & DRAFTSMEN

Plant Layout
Pressure Vessel
R. C. Industrial Structures
Piping arrangement
Structural Steelwork
Checkers

Employment will be in one of the most modern new office blocks in London's West End where excellent working conditions are available with scope for advancement in this American Company.

Please reply by mail giving full particulars to: —

D. GRIVE, CHIEF DRAFTSMAN, (Ref. Eng.)

CHEMICAL CONSTRUCTION (G.B.) LTD.
9 Henrietta Place, London, W.1
(Subsidiary of Chemical Construction Corporation, New York)

Interviews arranged locally. B 463

ERECTION MECHANICAL PLANT ENGINEER

responsible for inspection and maintenance of all mechanical construction plant, involving travel throughout the country (a car is provided). Age 28 to 35 with at least G.I.Mech.E. Apply in detail, quoting this paper and reference 4/60A to

The Staff Officer,
WHESSOE LIMITED,
Darlington.

B 460

Vacancies exist for good

DESIGNER DRAUGHTSMEN

to work on the development of specialised machinery and plant appropriate to the Photographic Industry. Good conditions and remuneration are offered with prospects of appointment as Engineering Assistants to applicants possessing suitable qualifications and ability.

Write in first instance to

Chief Development Engineer,
ILFORD LTD.
ILFORD · ESSEX

giving full particulars of education and career.

B 489

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line	4s. 6d.
(Minimum charge 18s.)	

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Rail Wagon Merger Talks

Two of the larger railway wagon and carriage makers of the United Kingdom are engaged in negotiations which, if successful, will bring them together.

The difficulties of the rolling stock manufacturers are well known, with British Railways at once cutting back its take up and satisfying its needs from railway workshops. The two companies concerned have gone about widening their activities in different ways.

They are CHARLES ROBERTS and Company, of Wakefield, Yorks., and the BIRMINGHAM RAILWAY CARRIAGE AND WAGON Company, of Smethwick, Staffordshire. Birmingham Railway has some useful work in hand for coaches for overseas railways, locomotives, railcars and restaurant cars for British Railways, and an important diversification proposal in the " preliminary " stage.

Charles Roberts has had similar experience to other wagon builders, although the chairman said in December that there was enough work to keep the plant employed for the next twelve months. The company has forged ahead with a considerable movement into hire purchase activities.

John Thompson South American Investment

Following its investment of £131,000 in the Argentinian company, S. A. ASTAR, of Buenos Aires, JOHN THOMPSON, the Wolverhampton firm of boilermakers and engineers, will be able to make its products in the Argentine.

New machinery is being installed and many of the John Thompson manufacturing techniques will be incorporated in Astar production arrangements. New rolls capable of rolling plates up to 70 mm thickness are being put in.

Since the Argentine reduced her dependence on outside oil supplies a considerable future has opened up for the development of her own oil and chemical industries. Astar, and in association with the company the John Thompson group, are moving into a strong position for supplying the equipment that will be needed.

Applications Engineering at AEI

ASSOCIATED ELECTRICAL INDUSTRIES has merged its application engineering departments (Heavy Plant Division) at Rugby and Manchester into a single new Plant Applications Engineering department.

The new department is the successor to the specialist departments set up years ago by the former BRITISH THOMSON-HOUSTON and METROPOLITAN-VICKERS ELECTRICAL companies to engage in the coordinated selection of electrical machines and design of control schemes. The formation of the AEI HEAVY PLANT DIVISION in July of 1958 was followed by the continuation of this work in two departments which have dealt with the application engineering of complete electric drives for rolling mills and mine winders and associated installations.

The new department will be led by Mr. Owen Evans, formerly manager of plant applications at Manchester. Mr. William Spence, who has been manager of plant applications at Rugby becomes deputy manager and assumes special responsibility for new schemes and control apparatus for the whole new department.

Mr. Evans, whose headquarters will be at Rugby, has the help of four engineers in charge. They are:

Mr. Leo Abram—mining projects

Mr. Phillip Peck—metal industries projects

Mr. John McTaggart—regulating systems and general projects

Mr. Harold Williams—control equipments.

Trends on the Manchester Ship Canal

The annual report of the MANCHESTER SHIP CANAL Company contains some useful pointers, in the shape of the comparison between last year and 1958 under the heading *Merchandise Traffic originating on the Company's System carried by Goods Train.*

The largest increase comparing the two years was in the carriage of copper, lead and aluminium, which increased from 47,571 tons to 74,406. Iron and steel, blooms, billets and ingots also increased heavily from 11,989 tons to, 31,699.

But iron and steel scrap went up only 5,000 tons to 32,092 and iron and steel (other descriptions) fell sharply from 135,971 to 96,079 tons. Iron ore carried on the system fell to 12,031 tons, little more than a third of what it had been in the previous year. Paper showed a substantial rise, improving from 28,221 to 45,842 tons.

Sir Leslie Roberts, the chairman and managing director, reports that the total receipts from ship canal tolls, ship dues, traffic rents and so on were £4,799,259, which was £129,199 better than in 1958. There was an increase in expenditure, including provisions against renewal of plant and works, of £109,591.

From a total sea-borne and barge traffic of 925,659 tons in 1894, the year of the Ship Canal's opening to traffic, the system has gained in importance until in 1959 the total was 18,558,210 tons. Although the gain has been fairly steady, apart from the fluctuations of wars and slumps, the upward trend in the figures has been sharp in recent years. 1949's total, 9,035,521 tons, was less than a million more than 1940's, but it was less than half that of 1959.

Sixty Years of Better Oil

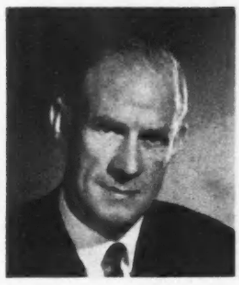
The C. C. WAKEFIELD CASTROL group have celebrated their 60th anniversary by moving into new headquarters in Marylebone, London. An all-British company, the group is now the largest independent lubricating oil group in the world. During those 60 years Castrol has been in use at many notable events that are milestones marking man's efforts to move with greater speed. Alcock and Brown were using Castrol when they flew the Atlantic in 1919. It has been used on numerous occasions when land and water speed records have been broken. The company claim to have been the first to have introduced additives to extend engine life (in 1935), and in 1938 they brought out their first lighter oils for easier starting.

Now their new 15 storey building, with its 12 storey glass tower, is one of the new sights of London, for at night the tower is floodlit internally through green glass panels which surround the building beneath the windows on each floor. In addition to office accommodation for the headquarters staff of 800, Castrol House has two restaurants, a showroom, several conference rooms, an underground garage that is much larger than building requirements yet demand, and a residential suite for group executives from overseas.

Oxygen in the 1960's

When Sir Owen Wansbrough-Jones became Scientific Adviser to the Army Council he was a moving spirit in the creation of the Shrivenham Royal Military College of Science and in introducing operational research to the Army.

Now that he has become a director of BRITISH OXYGEN it is not likely that he will be presented with another opportunity to carry out such fundamental work. The picture drawn by Mr. J. S. Hutchison (inset), the BOC chairman, in his annual statement is of a company reaping some of the benefits of intensive research and considerable



attention to sales service, and putting in multi-million pound equipment.

Mr. Hutchison's particular tag for the 1960's is that they are the decade of " tonnage oxygen," and the efforts of his group to bring this into effect are massive. The BOC chemical plant workshops at Edmonton, North London, will over the next two years be building 11 tonnage oxygen plants—costing about £6 million—and they are in the main for use by member companies of the British Oxygen group. At present the tonnage capacity of the group's Gases Division is 900 tons a day, but under contracts for the booming steelworks and their future extensions this is to be increased to 2,200 tons a day. BOC has fought many battles against intensive competition in coming to these arrangements.

The peak sales that the latter half of 1959 saw in liquid oxygen for steelmaking and other purposes are unlikely to remain standing as records any longer than next year's report. For two other gases, nitrogen and argon, demand increased last year but sales of acetylene, propane and, partly because of the lower sales in the first half of the year, compressed and liquid oxygen were not able to depart significantly from the sales figures of 1958.

The chairman looks forward to an improvement of the position of the Quasi-Arc automatic welding company as new products appear and with the extension of manufacturing facilities. Although orders were not so plentiful, Quasi-Arc maintained its position.

Overseas, BRITISH OXYGEN LINDE'S work on tonnage oxygen plants for the Durgapur and Rourkela steelworks in India are approaching completion. A tonnage oxygen plant has been installed at Port Kembla, Australia, to serve the steelworks there.

Improvement and expansion is reported from BOC factories in East Africa, Ceylon, Burma, Rhodesia, and Malaya. As has already been announced, extra plant is being installed in Hong Kong where there was an unexpectedly strong demand for oxygen for the cutting of scrap.

Nearer home, at Spadeadam rocket research station, installations undertaken by BRITISH OXYGEN WIMPEY Limited are being completed according to contract.

New Division at Stewarts and Lloyds

The complexity of the demands made upon pipework fabricators and the need to streamline the organisation have led STEWARTS AND LLOYDS to set up a Pipework Engineering Division.

The firm's experience in this field goes back almost as long as its hundred-year history in steel tube production. Pipework in modern practice is installed in anything from a small local works to a major new plant or power station.

The new division will have its own engineering, manufacturing and sales departments, and is equipped with radiography for non-destructive testing.

At the Tollcross, Glasgow, shops of Stewart and Lloyd, a " clean condition " shop, provides for the particular needs of nuclear plant.

The new division will have as managing director Sir Allan Eliott Lockhart, who was director general of Munitions production in India for the last year of the Second World War.

Westland Aircraft's Position

FAIREY AVIATION, the company conducting all the home air interests of the FAIREY COMPANY, has been bought for £3 million in cash and shares by the fast expanding WESTLAND AIRCRAFT company.

By this move Westland become the sole British manufacturer of helicopters; the developers of the Rotodyne; and and even more substantial industrial group than they were with the acquisition of the BRISTOL helicopter division and of SAUNDERS ROE.

Fairey, who will have £1,400,000 in cash for development, remain active in plastics, in boat building, in general engineering and in aviation abroad.

The latest Westland move now completes the situation which has previously been referred to where although there is plenty of critical competition from overseas makers—especially the Russians, Westland have an agreement with the American SIKORSKY firm—there is now a virtual helicopter monopoly at home.

The Rotodyne has had a difficult history and there have been times when it was very uncertain of thorough-going official support.

The development contract is now signed. The Rotodyne, a combination of turbo-prop and helicopter, is the world's first vertical take-off airliner.

Sharing Out the Value of Production

The individual incentive scheme has become anomalous. A plan which gives a fixed proportion of the production value to labour has given good results.

By F. R. Bentley, C.P.A.

In considering the question of incentives, one naturally tends to think of piece-work or time studied rates, both of which are based upon the volume of physical output obtained in pre-established working times. The origin of such methods of payment does, of course, go back to the days when craftsmanship played a very large part in industry, and the original intent was to reward the better than average worker in accord with the amount of work which he produced. Since those days industry has, however, become a vastly different organism. Craftsmanship has, to a very large extent, been supplanted by the machine and by the breaking down of the product into minor sub-components and sub-assemblies, leading eventually to a completed whole. As this pattern has progressed, there has been introduced a considerable amount of detailed planning, scheduling and progressing in order to secure a balanced flow, with an ultimate production to suit the order book.

Individual incentives, in circumstances such as these, would appear to have become an anomaly, and it would, in point of fact, be difficult to find many works managers who would honestly say that their existing individual incentive schemes drew the best effort from the great bulk of their employees. Admittedly, we have progressed from the rough rate fixing which once prevailed to the supposedly more scientific basis of time measurement but, in point of fact, has it really been progress or has it been an attempt to adorn a structure, which was increasingly disliked, with more attractive garments?

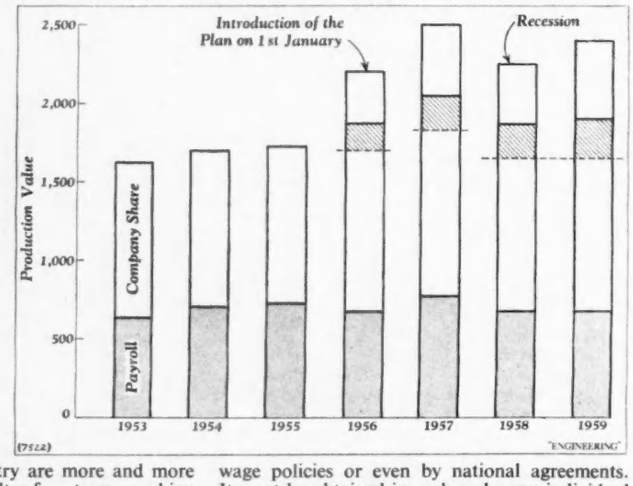
The basis of time study is to establish measurements which are based upon the effort of an average man working in average circumstances and working conditions at an average speed and allowing for a due proportion of fatigue. The points which must always occur to one's mind are, is there such an animal as an average man? Of what part of the day is he average? Would he be average if he had a row with his wife just before leaving for work or after attending a party the previous night? Is there such a thing as average working conditions in any workshop in the British Isles or do those conditions vary radically even within the same department? Is, in fact, this whole basis of averaging any better than a delusion?

As one examines piece-work and time studied wage structures throughout British industry, it becomes increasingly evident that while the times set may be fair and reasonable they produce no more from the man on the shop floor than he is prepared to give to obtain that wage packet which he feels is safe and reasonable. In many companies through the country the times and rates have been deliberately set in order to produce a pay packet which will attract the required volume of labour to the factory concerned, and if one examines the history of the endless small industrial disputes which are common within industry, by far the largest proportion of those disputes arise because of dissatisfaction over the times set or because of agitation which employees believe can be used to persuade the company to make the rates even more favourable.

Individual incentives have, of course, been increasingly used because they were the only method of payment which would obtain a greater physical volume of production than was previously being obtained, but we have moved into an era where, in those industries where individual incentives can be most easily applied, an ever increasing volume of work is now being carried by the machine itself and the individual operator can do little to influence it.

It is commonly believed that individual incentives are widely used in the United States where the time-studied basis of them originated, but, strangely enough, they have never met with the volume of favour in that country which they have received in Britain. American trade unions have rarely given their blessing and the trade union attitude in Britain has not been too enthusiastic.

The answer to the leading question must be that individual incentives have achieved some measure of success in producing probably more physical output than would have been produced by normal day work payments, but if one is to have success, and complete success, from an incentive scheme, surely one needs more than that. The handling of labour is undoubtedly the most difficult problem with which any management has to contend and, like many more very difficult problems, the tendency in such a case is for management to push the bulk of a difficult problem on to someone else in the hope that by so doing the problem will be kept out of management's hair. But can one solve any problem by pushing it under the table?



The results of giving 37½ per cent of production value to labour. During the three years preceding the introduction of the plan on 1 January, 1956, the production value was practically stable. From 1956 to 1959, a dotted line is drawn across the chart and the value above that line represents the increase in production value obtained. The dotted line rises and falls with the company payroll.

The products of industry are more and more becoming the final result of a team working together. Production starts with goods inwards and finishes in the despatch bay, but even before one receives materials on which to work a considerable amount of staff work has had to be carried through in designing, estimating and planning, etc., and the picture in one company after another is that the job is a team job. Why, therefore, must we fool ourselves into believing that by paying from 30 to 40 per cent of shop floor workers on piece-work we are giving the reward where that reward is due.

In all the discussions and arguments on the subject of wages and incentives no one ever seems to bother to ascertain the views of that person who is most affected—the man on the shop floor. The sociologist, the economist and quite a number of others can always give us the answer to the wages problem, but the man who has to do the work and who takes home the pay packet is rarely asked what his idea of a sound and proper wages structure really is. Nor does he ever seem to be asked what he really expects from his job and from the company in which he works. If he were asked he would almost certainly give the following replies. He would want a fair wage based upon his skill, his position in the company and the company's productivity; a feeling that he was a part of the company, not a clock number; a means which informed him of the progress which the company was making; a means of participation in improving his company; and some degree of security.

We often tend to forget that to the man on the shop floor his job is fully as vital and important as the managing director's job is to him, probably, in many cases, even more so, and surely we have got to the point where we must recognise the vast change in human knowledge and understanding which has taken place in the last decade and, in so doing, we must exercise a measure of leadership which has for too long been neglected.

In one company after another, in a wide variety of trades in British industry, a "share of production plan" has succeeded in producing astonishing results in circumstances which were far from favourable. It has evoked a degree of cooperation from the shop floor which is setting a new pattern in industrial relationships and, whether we like it or not, industry must and will always have to depend on people. We cannot, if this country is going to survive in the field of ever increasing world competition, envisage any return to the old days of continual industrial strife, but if we are to have peace in industry we cannot obtain it by means of national wage policies or even by national agreements. It must be obtained in each and every individual factory by management and employees learning that they are a team and that they must work together as a team.

The basis of the share of production plan is to establish from a company's own past trading figures a measurement of internal productivity in that company per pound of wages paid. An examination of all economic records which are available conclusively proves that of the value produced by industry a near constant percentage is regularly paid in wages, either nationally by industry or in the individual company, and in spite of all the theory to the contrary, that percentage is held in balance year after year by the millions of economic factors which affect the trading of any concern.

One cannot measure either production or productivity in terms of physical units. The number of motor cars, the yards of cloth, the number of television sets are no basis of measurement and, in any event, all of them are converted into money for trading purposes. Obviously the best method of measurement is, therefore, the common unit of money, and in establishing this for an individual company, one must first ascertain the sales value of that company's production, taking into account not only sales but work in progress and finished stocks, which have, in point of fact, been produced. To obtain that sales value of production

every company utilises outside materials, both raw and finished, consumable stores in endless variety, and services such as gas, water, fuel, power. Deducting these from sales value of production will give the production value of a company, and of this production value shop floor labour as a team will have had, year in and year out, a near constant percentage. That percentage can then be used to assure employees that they have always had and will always get their fair share of the production value created in their company, and to that simple fact alone they have given an astonishing response, for in every company where this principle has been applied there has been a sharp increase in the production value obtained from existing buildings, machinery and men.

In order to make a scheme of this nature succeed, one must, however, go further than mere monetary payment. That, in itself, is important, but it is equally important to give employees the operating figures month by month. They are interested, they are concerned, and they will respond immediately to any points which may arise when those figures are discussed between themselves and the management. This discussion normally takes place in a share of production committee which is half freely elected employees' representatives and half management, and which meets once monthly for approximately one hour. Apart from the figures which are presented to that committee, it acts as a channel for any ideas and suggestions which men on the shop floor feel may improve productivity.

The plan gives management an opportunity to give the employees information which they are avidly awaiting and it has, in many instances, opened the eyes of management to many conditions in their own companies of which they were previously unaware.

In establishing figures for a share of production plan scheme there is no element of " loading " in those figures to automatically produce a bonus as a result of normal operations. The plan will produce results only when there is an increase in productivity either from greater physical output, less rejects and rectifications, greater care in the use of materials, supplies and services, and a constant flow of ideas which both sides cooperate in putting into effect. In other words, if the plan produces a bonus for employees, that bonus must be earned and the company must also gain in its pre-established proportion.

As one reviews four years' working of the plan in a variety of concerns, varying in both size and trade, in British industry, a number of salient facts emerge. Employees have benefited by increased earnings, ranging from 10 per cent in the first year to more than 30 per cent in the third year of operation. In cases where the order book has fallen off and bonus earnings dropped, the degree of cooperation which employees have given to management has been even greater than in times of high prosperity. Company profits have increased substantially and in direct ratio to the gains made by employees. The problem of communication has been solved, for in every company employees are better informed and consequently far more interested in the progress of the business. The share of production committees have produced a wealth of ideas from the shop floor, most of which have been eminently practicable and all of which have contributed to greater productivity. The work of management and supervision has been greatly reduced because of the completely new attitude of a cooperative working force.

The chart shows the picture in a typical share of production plan installation and has been purposely taken over a period of years, three of which were prior to the installation of the plan and were included in the six years on which basic figures were established, and four years since the installation of the plan. The company concerned is in engineering, is known throughout the British Isles and is generally regarded by its competitors as a highly efficient concern on price, quality and organisation.

In this company the ratios are 37½ per cent of production value to labour; 62½ per cent to the company. It will be noted that in the three years before the installation of the plan which began operation on 1 January, 1956, the company's production value was practically stable. From 1956 to 1959 a dotted line is drawn across the chart and the value above that line represents the increase in production value obtained. It is worthy of note that in spite of repeated engineering wage awards the actual payroll in this company has remained comparatively stable over a seven year period. After installation was made we find a substantial increase in the production value obtained from roughly the same payroll. Of that increase, the section which is hatched in indicates the amount distributed in bonus in addition to the payroll, and the upper half of the section above the dotted line indicates the gain made by the company.

In this company, management/employee relations have been extremely good in many years and the chart is a very true indication of the fact that even in a highly efficient company a considerable gain in productivity can be obtained from the same buildings, machinery and men once people have learned to live and work together as a team.

Research into Tapping

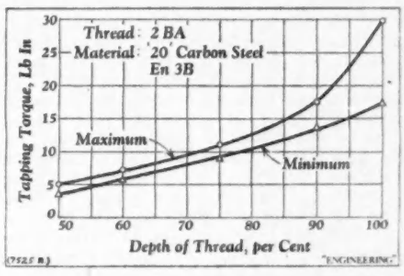
The Production Engineering Research Association has released for general circulation a report on the relationship between core hole size, tapping torque and thread strength.

A comparison of the results for all materials studied in the report, shows that the torque required to tap BSW threads is higher than the torque required to tap the corresponding BSF and BA threads. There is one exception in the results, that for cast iron, where the tapping torque for 2BA is higher than the $\frac{3}{16}$ in BSW.

Tapping torque may be divided into two main forces: the first being the force required to shear the chip from the workpiece, and the second, the force required to overcome the binding and jamming of the swarf in the tap flutes.

The BSW taps remove a greater amount of material than the corresponding BSF taps and therefore require greater flute capacity to accommodate the swarf. At the same time, the torque required to cut the BSW threads is higher than that required to cut the corresponding BSF threads and therefore the BSW taps require great torsional strength.

The compromise between flute capacity and torsional strength in the case of the BSF taps allows greater swarf clearance relative to the amount of material removed. For all tap sizes, swarf jamming is more severe at higher percentage depths of thread. These remarks do not apply to the tapping of cast iron where the chip formation is discontinuous. The accompanying graph shows typical variations in tapping torque at different percentage depths of thread. The difference between minimum and maximum tapping torque for 12 specimens increases as the percentage depth of thread increases.



Variations in tapping torque at different percentage depths of thread.

Cutting Metal at 3,000 m.p.h.

The Lockheed Aircraft Corporation have announced that they are using a 20 mm cannon in tests on new ultra-high-speed cutting techniques for building future jet transport aircraft. Working under a contract from the United States Air Force Air Materiel Command, Lockheeds have achieved tool machining speeds of more than 3,000 m.p.h. In the development programme which has led to this, high-strength steel and titanium alloys were successfully tested at machining velocities up to 250,000 surface ft per min. That is more than 16 times faster than cutting speeds now used for aluminium and more than 6,000 times faster than speeds now used on hardened steel and titanium.

For the tests, the company used a modified 20 mm cannon to fire workpieces past a tool fixed to a special extention to the barrel. The workpieces were aluminium, titanium and steel projectiles, varying in length from 1¾ to 12 in, and propelled by standard 20 mm hand-loaded cartridges. By varying the type and weight of the powder charge and the weight of the projectile workpiece, cutting speeds ranging from 15,000 to 250,000 surface ft per min were obtained.

Conventional high-speed tool steel, ⅜ and ½ in square, tools were used for the experiment. Each cutting tool was used only once to establish a direct comparison between tool wear, cutting speed and metallurgical change.

In this type of test, perhaps the most difficult part is measuring and recording the results of the experiment. Although no details of how this was done are available at present, the following instruments are reported to have been used. Oscilloscopes to record forces, temperatures and system frequencies. Electronic counters were used to measure projectile velocities before and during the cut to an accuracy of 1 μ-sec. High speed framing cameras were used to photograph both chip formation and chip velocity. A time-interval meter was used to record post-cut velocities, and thermo-couples on the tool bit were employed to measure tool temperature.

The materials tested included AISI 4340 steel, AM 350, Inconel X, 6A1-4V titanium, and 7075-T6 aluminium, all in the fully-hardened condition.

After a number of tests in the company laboratory, additional tests were carried out at Edwards Air Force Base, where the well-known rocket sled run was used to test a workpiece too large for indoor tests. In these tests, maximum velocities of 1,080 ft per sec were reached (approximately Mach 1).

Results of long cuts (4 ft) made on the sled track compared closely with those obtained from projectile tests made with the cannon, and Lockheeds concluded that increasing tool cutting time eight-fold had no effect on the result. In both indoor and outdoor tests, 120,000 ft per min proved to be the best machining speed for minimum tool wear under conditions tested on AISI 4340 steel. No upper limit was established for machining speed during the research tests.

Loading and Unloading a Nuclear Reactor

In a commercial nuclear power station spent fuel elements must be replaced while the reactor is under load.

Like its thermal counterpart, a nuclear power station has to be supplied with fresh fuel as the elements become unsuitable due to changes in their atomic structure, and must be removed in a highly radioactive condition. In addition, provision has to be made for controlling the atomic reaction and also assessing accurately the future fuel requirements. On occasion, too, the control equipment for these purposes needs to be withdrawn for servicing. All this work must obviously be done by remote control while the reactor is under load, and the operating machinery has to withstand and protect the operator from gamma and neutron radiation, in addition to meeting more conventional requirements of heat-resistance (up to 350° C) and pressure-tightness (125 lb per sq. in gauge). In certain cases the machinery will become highly radioactive in use, so that it cannot be manually maintained, and must therefore be built to extremely high standards of mechanical reliability. The main item in this category is the charge chute. The charge face machinery at Berkeley power station has been designed by the John Thompson Ordnance Company.

Berkeley has two reactors, each using natural uranium bars canned in Magnox as fuel. The graphite cores are 48 ft diameter and 30 ft high, contained in a 50 ft diameter cylindrical pressure vessel 80 ft high made of 3 in thick steel. There are 3,000 fuel channels formed in the graphite blocks, and each channel contains 13 fuel elements, resting on a spacer and a gag. A 100 ton capacity electric overhead mast crane extending over the charge face enables any of the machines to be lifted to its particular operating position and parked when out of use.

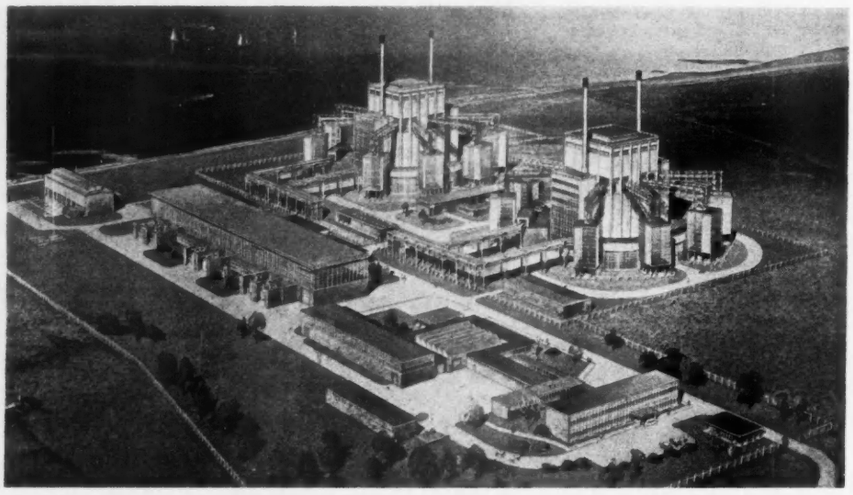
To bridge the gap between the charge face floor and the reactor pile, chutes are used, and a 50 ft high chute machine is provided for handling the chutes into and out of their working position. One operational and one spare chute machine are being supplied for each reactor charge face. The chute machine includes a pressure vessel which is connected to the reactor via a standpipe, and the grab and winding mechanism used for hoisting and lowering the chutes are contained within the pressure vessel which is shielded against radiation. A three-chambered chute magazine capable of holding the 40 ft chutes, and mechanism for actuating the grab and for supporting a load, are also enclosed in the pressure vessel. The chute machine is placed by the overhead crane on an operational skirt when working over a charge point, the inspection well or decontamination well. A control panel outside the main shielding, with electric interlocks which fail to safety, enables the machine to be controlled by push buttons.

With this machine, charging, flux scanning, or fixed absorber chutes, or control rod guide tubes can be handled in and out of the reactor.

Two machines are provided on each charge face for fuel element placing and removal, and there is a standby machine kept in the maintenance shop. Basically, each machine is a winding mechanism with a grab capable of engaging or disengaging a fuel element by remote control. The main working parts are enclosed in a shielded pressure vessel. A rotating internal magazine is designed to hold 13 fuel elements, a gag and four concrete plugs which seal the chute, one compartment being spare.

To charge fuel, the machine is located on a skirt over the fuel loading conveyor and picks up fuel elements and stores them in its magazine. It is then lifted by the crane to an operating skirt over the appropriate fuel channel and the elements are lowered into position through the chute and into the pile. For removing used fuel elements, the machine reverses its operation, and is then lifted and located on the discharge well skirt, when the elements are taken away for disposal. A circulating, cleansing and cooling system, normally using air but changed to CO_2 when the machine is connected to the reactor, is fitted. Power to the machine for the maintenance of interlocks, safety devices and to keep the pair of independent circulating blowers and cooling fans running while the machine is being lifted, is achieved by plugging into a supply on the crane fork.

For operating the machine, power and hand drives, indicator and interlock wiring, pass through the pressure vessel and shielding to a control panel. From this point the sequence of operations can be carried out either completely manually as in the case of a power failure to the machine (batteries on the machine maintain indicating and interlock circuits), by individual push button, or completely automatically.



Artist's impression of Berkeley power station.

The reactor contains a large number of control rods, some of which, known as fixed absorbers, are left permanently in place; the majority, however, are connected by wire cables to winches. These winches, or actuators, are about 15 in diameter and 12 ft long, and weigh about 15 cwt. They have to be removed from time to time for servicing, and a control rod and actuator servicing machine (CRASM) is provided for this purpose. Standing about 50 ft high and resembling, externally, the chute machine, the CRASM consists of a magazine section containing grabs and their winding gear, and a support or skirt section complete with various tools by which the actuator can be connected to or separated from its control rod.

There are four magazines; one for a clean (uncontaminated) actuator, one for a dirty (contaminated) actuator, one for a clean control rod and one for a dirty rod. Each magazine has its own grab and independent winding gear. The shielded skirt section has two operating tools, a manipulating tool and a cable recovery tool, the former enabling the control rod to be connected to or disconnected from the cable on the actuator, and the latter enabling the control rod and cable to be recovered should an actuator become defective. Two periscopes are fitted to assist in these operations. A trolley-mounted control panel enables the sequence of operations to be carried out.

Several different skirts are provided, all being primarily support structures, with the exception of the CRASM skirt, which is itself a pressure vessel and a machine. Semi-permanent support skirts are provided for the loading conveyor, the discharge well, and for high and low parking.

The loading conveyor skirt supports the charge machine while it is being refilled, and the discharge skirt takes the charge machine, chute machine, visual observation and recovery equipment and the CRASM. For parking there is a low parking skirt positioned near the entrance to the maintenance bay, and near to it is the high parking skirt, which can accept any machine.

The operational skirt can be positioned where required on the charge floor and can accept any machine. Its walls are shielded, and locating dowels are fitted on the upper surface

Limited observation of the interior of the reactor is possible by means of closed-circuit television, incorporated in the visual observation and removal equipment (VORE), which is also equipped with a selection of grabs for recovering portions of a broken fuel element or other material from the fuel channel. Such material is stored in removable containers in a 20 channel magazine, for later disposal. A turret located above the magazine carries a variety of workheads which can be placed in position on the camera grab at will. Remote control is fitted to the grab selection and operation mechanism, the camera and the chute and magazine gear.

For determining future fuel requirements, a flux scanning winch is used. This, operated in association with the flux scanning chute, lowers a tungsten wire into the reactor, where the wire absorbs radioactivity at a rate dependent upon the condition of the surrounding fuel elements. After the wire has been recovered, the radioactivity is measured, and a graphical record is kept. Twenty-six of these machines are provided for each reactor, so that a number of readings can be taken simultaneously.

For loading new fuel elements into the charge machine, a conveyor is provided. It consists of two horizontal endless chains, with 16 compartments of approximately the same section as the tube in the charge machine magazine, supported between them. Stops in the bottom of each compartment hold the fuel element, which is lowered into place by the loader. The compartments are so spaced that they extend over half the conveyor only; when the first is under the loader, the other is under the skirt of the charge machine.

The loader is a roller chain passing over a single sprocket and having at one end a carrier and at the other a balance weight. A handle turns the sprocket through a spring-loaded clutch which prevents overload, and at the same time this spring loads a brake to prevent the element falling into the conveyor.

Keeping Diesel Fuel Systems in Trim

Diesel fuel injection systems must be given regular care and attention. A new service school at Halifax provides instruction for users of servicing equipment.

Modern diesel engine fuel injection equipment is fundamentally simple in design, robust in construction, and capable of giving long service under widely varying conditions. But for peak performance it must be properly maintained, and with the ever-increasing use of diesel engines, servicing is becoming of growing importance.

A diesel engine user can adopt one of two obvious courses in dealing with maintenance; he can send the engine or its pump and injectors to a specialised diesel service concern, or he can undertake the maintenance in his own workshops. In the case of a small user (of one or two motor vehicles, for example) sending the work to an outside specialist may be the only reasonable way to deal with the matter, but where the user has a larger number of engines, servicing on the premises is an attractive proposition, and is becoming widespread. Because of this increase in maintenance by users, the Merlin Engineering Company Limited, Salterhebble, Halifax, have built a training school for instructing users' mechanics in the operation of Merlin testing and servicing equipment.

FROM VANS TO SHIPS

Since diesel engines are made in sizes ranging from a small unit of a few horsepower for a light vehicle or an item of industrial plant up to large stationary and marine units having a large power output, the needs of fuel servicing equipment users are extremely varied. Some diesel users have a large number of similar engines; bus and transport fleet operators are examples of this group. Others have an extremely wide range of types and sizes in service. Public works contractors are probably the best example of the "varied" group. Their equipment may range from small engines driving portable pumps, compressors or electric generators to very heavy earthmoving machinery.

Merlin Engineering have taken all these factors into account in planning their school. They produce a range of servicing equipment which will deal with every type and size of diesel fuel pump and injector made, and the complete range is installed in the school. It is therefore possible to give instruction to a users' mechanic whatever type of diesel engine he may be expected to maintain. Courses last from two to five days according to individual requirements. There is sufficient space and equipment in the school to enable groups of up to about six men to be accommodated easily, but smaller numbers, down to a single individual, are given instruction if required. A complete range of pumps and injectors is kept in the school, and the courses cover the stripping, examination, rectification, reassembly and testing of the fuel equipment.

Fuel for a diesel engine passes through several pieces of equipment on its way to the combustion chamber. Its movement can be visualised as a straight line; supply tank—feed or lift pump—filters—injection pump and governor—delivery valves—injectors—combustion chamber. Each of the items in the line must function correctly at all times, and a Merlin maintenance course takes each one in turn and examines its individual features and peculiarities.

No special equipment is needed for testing the supply tank. It only has to be kept clean and free from sludge and the outlet should be adequately filtered. Immediately following the tank in the fuel feed line is the feed or lift pump, which is usually either attached to or integral with, the injection pump. Three types of feed pump are in normal use; diaphragm, plunger and gear. All types should be tested for general efficiency, the suction, pressure and delivery volume being checked in accordance with the pump-maker's specification. A Merlin "Calimaster" fuel pump test machine is used for this purpose. There are seven models of this machine, of various capacities to suit pumps of different sizes, but the operating principle of the machines is common to the range. This machine is of the universal type, being capable not only of testing feed pumps, but also of dealing with injection pumps as well, and of giving a simulated run under operating conditions.

INJECTION PUMP

Fuel injection pumps have to supply fuel at pressures up to 175 atmospheres (or more on large engines) and in quantities ranging from 40 to 16,000 cu. mm per stroke per element, according to engine size. Output from each element is adjustable, and the Calimaster is used to measure the quantities delivered, adjustments being made as required. It is usual to test the output over runs of 100 or 200 injections at various speeds. An automatic cut-off stops the machine at the end of the chosen number of injections.

In addition to calibration, injection pumps have to be timed and phased. This work, again, is done on the Calimaster. First, the pump is set to supply fuel to No. 1 injector at the correct time in relation to the engine piston position. A unilateral tolerance of 2° on the engine flywheel or 1° on the fuel pump camshaft is allowed. When the timing is set correctly, a mark is made on the pump half coupling and body, so that the pump can be refitted on the engine in correct relationship to the marks on the flywheel. Phasing is the next operation. This involves setting the remaining pump elements to their correct angular position relative to No. 1; 90° for four-cylinder engines or 60° for six cylinders, for example. A unilateral tolerance of 1° is allowed on the pump camshaft. Phasing can be done by adjusting each element individually with the pump stationary, or it can be done by means of stroboscopic equipment built into the "Calimaster"; this equipment is an optional extra.

Having timed and phased the pump it only remains to set the governor and check the delivery valves. Separate equipment is provided for this purpose.

INJECTORS

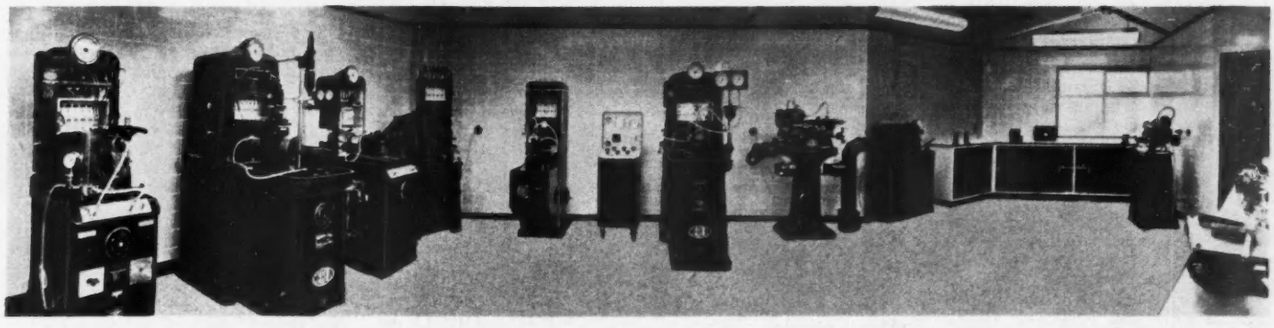
Testing injectors is partly visual and partly mechanical. Visual examination will discover such faults as carbon deposits in the holes, or sticking needles, but when the injector is correctly assembled, it must be tested to see that it delivers fuel correctly atomized, that the seating is tight, that there is no back leak between needle and bore lap, and that the release pressure setting is correct. This is done in a Merlin hand-operated test rig, with a pump and pressure gauge.

Finally, it is necessary to examine and rectify if necessary the high pressure piping connecting the fuel pump high pressure outlet to the injectors. Faults which may be found here include nipples in bad condition, burrs in the ends of the pipe, and foreign matter clogged in the fuel line.

Examination and testing of the various components of a fuel system may disclose faults of many kinds, some of which can be rectified by cleaning or adjustment, while others can only be cured by reconditioning component parts or, in the worst cases, by replacing them. Instruction on this work is also given in the Merlin school, and several types of reconditioning machine are installed.

Injectors in particular are likely to need rectification, and the Merlin "Servicemaster" is specially designed to deal with this problem. It is available in more than one model, but, as is the case with the pump testing machines, the principle remains the same throughout the range. A combined external grinding and lapping machine, the Servicemaster is a precision tool capable of regrinding the fuel injector needle and lapping the seat in the body to the close limits and fine finishes required. Using this machine a reasonably skilled operator can lap 90 holes or grind the same number of needle points in an hour.

Merlin equipment is installed in over 5,000 diesel service centres in various parts of the world, and the Merlin Engineering Company have for some time given instruction to operators in older premises. In view of the demand, however, for courses from users both large and small, it was decided that the former facilities were inadequate, and new premises were built. Instructional courses at Halifax are supplemented where necessary by demonstrators using mobile equipment at users' premises, both services being provided free of charge.



A complete range of diesel fuel system testing and servicing equipment is installed in the Merlin instruction school at Halifax.

On the Shelf

By Frank H. Smith

Let me give you an occasion for hopping madness. Take a firm whose reputation is world-wide, whose products are internationally known, whose integrity is 100 per cent (or more). They ask an agent in this country to take out a sub. to an American periodical.

The agent writes back and says, sorry but the publishers will not accept a subscription until they know exactly what the firm produces, who their customers are, what their standing is and so forth. Can you imagine the approach to berserkery of the client? Can you imagine the face-redness (through no fault of his) of the poor agent? That poor bee has to placate the irate customer and at the same time play ball with the fatuous publisher. And why? So that the man the other side of the pond can say to his advertisers "Our circulation is 25 copies per week EVERY ONE OF WHICH GOES TO A POTENTIAL CUSTOMER OF YOURS."

Just how crazy can this racket get? For the sake of goodwill one would have thought that a guaranteed 80 per cent of potential customers would have been enough. It would serve these publishers right if they lost the whole of the market for their journals or if the advertisers (for being such darned fools to listen to such talk) got not a single return from those journals. To give some idea of the lengths these people go to I might mention that I have been given the names of Rolls-Royce, E.M.I. and Kodak as firms that have to be quizzed and if these publishers (whose names I withhold to save their shame) do not know what those three firms produce they ought never to be in business. And if the cap fits, I hope you wear it and may it make you as bald as I am.

I don't pretend to understand what this is all about but it's Nos. 1/2 of Vol. 1 of *Plasma Physics—Accelerators—Thermonuclear Research* dated October, 1959, with five general editors and four executive dittoes and an editor in chief. *Journal of Nuclear Energy, Part C*, also comes into it and Pergamon will tell you all. By the way—Pergamon Press Limited, Headington Hill Hall, Oxford, now, so bear it in mind and alter your address book according.

The Polish Academy of Sciences, Institute of Basic Technical Problems, Warsaw, has brought out No. 1 of *Proceedings of Vibration Problems* which they are prepared to exchange (Dept. of Vibrations IBTP-Warsaw-Swietokrzyska 21) or sell (ARS Polona-Warsaw-Krakowskie Przedmiescie 7) but it looks as though 1961 will be the first copies available for purchase.

The Japan Society of Mechanical Engineers (561 Marunouchi Building, Chiyoda-ku, Tokyo) is interested in exchange. This body has been going since 1897 but hitherto its publications have been in Jap. From 1958, however, they've had a *Bulletin* in English (and by *Bulletin* they mean quite a fair sized journal) first, twice a year and now quarterly. It is worth a swap.

From Heinemann (William—Ltd.) at 15-16 Queen Street, London, W1, you can get a one-subject book list on Physics.

Apart from regular arrivals on my desk, I occasionally get the odd pamphlet, journal, house magazine and what have you that some other department has no further use for but hasn't the heart to throw away. The result is that I see, say, number five of an item that I did not know existed. Here, for instance, is No. 3 of *Roto-Finish Record* (Roto-Finish Limited, Mark Road, Hemel Hempstead). It is only a four page leaflet but R-F, it seems, go in for metal and plastic finishing. It's an Anglo-Dutch (or Nederlandische-English) concern and will send you details of such things as barrelling plant and processes, chips and compounds (fish 'n' chips?), separators, Grisiron alkaline cleaners, and so on. The telephone number is Boxmoor 4600.

Way to the Stars

Vistas in Astronautics. Volume 2: Second Annual Astronautics Symposium held by Air Force Office of Scientific Research and Institute of Aeronautical Sciences. Edited by MORTON ALPERIN and HOLLINGSWORTH F. GREGORY. *Pergamon Press.* (105*s*)

Only a few years ago the word astronautics would scarcely have found a place in the title of a serious scientific symposium. The subject had been treated sanely enough by the great pioneers and enthusiasts Tsiolkovsky, Oberth and Goddard but for most people their work was obscured by a mass of science fiction. With the advent of the Sputniks, astronautics suddenly became respectable. Indeed so respectable has it become that, in the United States at any rate, it is already a subject with text books and examination questions. What is it all about? And where is it all leading to? "*Per ardua ad astra*" is all right for the Royal Air Force but it does not necessarily follow that it is a suitable motto for the whole human race.

For a little over a decade following the end of the war, rockets were used, principally in the States, for the study of the upper atmosphere and of the relationship of our earth to its environment (especially to the sun). In the USSR, on the other hand, much of the research of the period had a biological and physiological slant. The avowed intention of the work done in the West was purely scientific. On the other hand it seems probable that the Soviet aim from the first has been space travel. Indeed maybe we can see here an unconscious distinction between Western science with its historically theistic roots and Marxist science with its basis in humanism. Such was the impact of the Sputniks that the United States rushed, one might say stampeded into work aimed to put man into space, and now for better or for worse the race is on. Fortunately there is no fear of this country following blindly in a race it could not win. Instead we have chosen to press forward our programme of scientific research but as we do so it is valuable to look out over the *Vistas in Astronautics*, to look, so to speak, before we leap, for not every vista is equally inviting. *Vistas in Astronautics* is the work of many authors, some of whom tend to be trite.

In a spoken symposium this is not entirely bad. It provides a sort of social lubrication like saying "good morning" but in a book it is annoying—and costly. Sometimes in the discussions verbose replies have been given to naive and ignorant questions. Rather rarely have they been answered. Once, at any rate, the reply had no connection whatever with the question. All this is a symptom of the bad editing and worse proof reading. This could have been a good book for there is much excellent material. Editing should have eliminated such remarks as "imagine a sexy computing machine," or the curious mixture (all in one contribution) of degrees Fahrenheit and Centigrade, of watts, foot candles, B.t.u's, centimetres and inches.

The papers vary immensely. One author feels it necessary to remark about reaction that "the scientific term for this effect is 'conservation of momentum'."

This is not the kind of book that will be widely purchased by private individuals. The interest and value of the contributions is far too variable, as indeed is the standard of education and specialisation assumed. On the other hand it is a book that should find a place in the libraries of scientific and engineering laboratories. The prospective reader should take no notice of the small print discussions, or of papers with titles like "How High the Moon" (sic.) and very little notice of the panel discussions. This will leave him with four parts each containing several good papers. The titles of these parts are: Space environment and Vacuum Research; Control and Propulsion of Vehicles outside the Atmosphere; Departure, Space Navigation and Re-entry Problems; and The Earth's Moon. Of special interest are the papers on ion propulsion because the work is so new. A magnificently illustrated authoritative paper by Kuiper entitled "The Exploration of the Moon," is also one of the best contributions.

R. L. F. BOYD

A Short War Extended

The Economic Blockade. By W. N. MEDLICOTT. Volume 2. History of the Second World War United Kingdom Civil Series. *Her Majesty's Stationery Office*; and *Longmans, Green and Company.* (50*s*)

What type of intellectual discipline gives the best background for assessing the unknowns in the formulation of policy in modern war? Is it engineering, mathematics, economics, classics—or is it a flair for playing a deadly variant of chess? At the Ministry of Economic Warfare during the war the economists were on the whole in the ascendant, although they took their basic thinking, or had it imposed on them, from their political masters like other officials. Yet they do not seem seriously or effectively to have challenged two basic tenets of economic strategy which were eventually proved wrong at least in emphasis.

These mistaken concepts were the effectiveness of small air raids on key installations behind the lines and the usefulness of the blockade. Was all this the emotional reaction to Guernica and the presence at the new ministry of economic historians who knew their Napoleonic Wars just a shade too well? Would a few more men of technical training and experience with a less lively appreciation of the suggestiveness of historic parallels been a better basis of recruitment? Perhaps it does not matter, for maybe we shall not look upon its like again. So indeed the author of the book thinks.

This second and concluding volume of Professor Medlicott's history of the blockade covers the period from the summer of 1941 to that of 1945, from the eve of the German attack on Russia until the German collapse. It takes its place as a worthy addition to the series. It has indeed many of the virtues and the limitations of the series as a whole. It is painstaking without being pedantic. Granted the nature of the subject matter, the style is clear and readable.

Professor Medlicott has had the same difficult task as other contributors to the History of the Second World War series that he has had to describe and discuss policy and basic issues while giving full coverage to a mass of administrative detail. In this kind of writing there can be no relief as there is for the military historian, however brief, in fleeting glimpses of men in action and allusions and brief descriptions of the battlefield. In this case the pen is not only mightier than the sword: it is the sword. Like all the others in the series, and being an official history recorded for the future benefit of economic war-wagers, it is devoid of any human interest. It is all meetings and minutes. Personalities and place-seeking never emerge above the unruffled calm of the narrative. One cries out occasionally for an excerpt from a witty minute or the distant dropping of an administrative brick but they never come. This is however a shortcoming of the series, not of this particular author.

The book has to be judged on two criteria. First, is it a thorough account of the administrative minutiae of the conduct of economic warfare in the Second World War? So far as one can tell from a single reading it measures up to this requirement. It falls into two sections—the gradual entanglement of the United States in the war, which

the author calls "the American Impact" and then the final allied onslaught in terms of economic warfare which he calls "The Final Attack." These two follow each other in chronological order. Within these two general sections Professor Medlicott discusses the administrative development of certain ideas about the control of trade as between the United States and the United Kingdom and then goes on to show how these ideas were worked out in the case of each of the main neutrals. This last part is inevitably somewhat detailed and repetitive to the general reader who wants to travel fairly fast over the 700 odd pages. They are repetitive however only in the sense that the same ideas were being worked out in very different contexts. It is the earlier chapters, and the final ones in the book, which will interest the general reader most.

The second criteria by which the book has to be judged is whether its author manages to see the wood from the very considerable mass of trees. Here again the verdict is favourable, in so far as it can be without going over the same mass of official papers as the author has done and forming an independent judgment. The main assumptions deciding economic policy in Germany and the allied attempts to find these assumptions and to work out a policy for economic warfare accordingly are clearly set out and the author clearly gives his judgment on it all at the end.

It is this aspect of the book which will rouse most general interest. One wants to know, if one is interested in the history of economic warfare (and this book is not for the general reader unless he is interested) what the essence of this warfare was from the United Kingdom and American side. Was our policy the right one and was there indeed a policy at all? What were the basic strategic issues which the Ministry of Economic Warfare had to cope with? Did it make the right guesses about German strength and weakness at the right time? How important was its contribution to the war effort as a whole?

The British assumed that the Germans had geared their war effort to a short conflict and in this they were right. They went on to think therefore in terms of vulnerable economic targets for bombing attacks and German vulnerability in key stocks of materials. They were logically right but "technically" wrong. They over-estimated the ability of small bomber forces (which was all there were available till well on in the war) to knock out industrial plants and they underestimated the German ability to develop ingenious substitute materials or sources of supply. They also underestimated German ability to change over—with partial success—from a short-war to a long-war policy thanks to the organising ability of Speers, the German Minister for Armaments and Production. They were thus eternally optimistic—though Professor Medlicott thinks, probably correctly, that this attitude was to help boost morale in Whitehall and outside it.

Much of this volume is naturally concerned with the entry of Japan into the war and the efforts to blockade her. The sections dealing with the policy of keeping Germany and Japan from exchanging key materials and the use of the blockade against Japan (a classic target for economic blockade with her long coastline and lengthy separation by sea from sources of raw materials) are particularly clearly set out.

But when all has been said about the great degree of success of Anglo-American cooperation, the clear thinking at administrative level of the issues at stake and the amount of ingenuity which went into economic tactics, the author's verdict is lukewarm. He grants that the fear of blockade was strong in Germany (it helped to precipitate the major German blunder of the attack on Russia) and that we were therefore right to play it for all we were worth. But the British idea of blockade failed and the successes were won mainly in control of movements of goods into the Axis territories at source, a technique of control in which the Americans played a very big part.

Professor Medlicott doubts if there is in all this any great fund of knowledge and experience for the future. The geographical position of Germany in two wars lent itself to the use of slow economic strangulation against her. In this case economic blockade played a useful, but limited, part in victory. Guided missiles and other big technical advances in many fields have probably put the navicert and all that went with it on the shelves of history along with the privateer and the battleship.

G. E. TEWSON

Aspects of German Engineering

Forschungsberichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen. (*a*) Gesamtverzeichnis. (*b*) Bericht. Nr. 548. By KARL LEIST and JOSEPH WEBER. *Westdeutscher Verlag, Ophovener Strasse 1-3, Opladen, Germany.* (8·30 *DM*)

Der Wirtschaftliche Dampfkesselbetrieb. By HEINRICH KOLBE. 4th Edition. Volume I *Wilhelm Knapp, Halle (Saale), Germany.*

Die Zahnformen der Zahnräder. By HERMANN TRIER. 5th edition. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf, Germany.* (3·60 *DM*)

Hydraulische Antriebe. By A. DÜRR and O. WACHTER. 4th Edition. *Carl Hanser Verlag, Kolbergerstrasse 22, München 27, Germany.* (19·80 *DM*)

No visitor to the German state of Nordrhein-Westfalen, containing as it does such towns as Düsseldorf and Aachen, as well as the Ruhr, can have failed to notice not merely the way in which the skyline is changing, but also the immense drive which informs all that is going on whether in industry or in the universities. The catalogue of pure and applied research work which has been published in the state, and which is obtainable free from the publisher, gives some idea of the way in which every effort is being made to bring Germany back into its former position as one of the leading scientific countries of the world. A typical report, *Forschungsberichte des Wirtschafts-und Verkehrsministeriums Nordrhein-Westfalen*, is a useful photoelastic study of the stresses in turbine rotors with blades milled from the solid and with Laval type blade fixings. The same publisher also puts out a list of the publications of the *Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen*, which lists the publications of a group of men from all faculties, both scientific and general, which has been formed with the object of trying to break down some of the barriers which tend to exist between subjects, barriers which are even more evident in Germany than they are here, due to the fact that in Germany engineering is taught exclusively in the technical universities, and that the universities themselves are highly departmentalised. The publications listed include a number by leading British figures.

Anything coming from the other side of the Iron Curtain tends to have a mildly hypnotic effect, even if, as with *Der Wirtschaftsliche Dampfkesselbetrieb*, the book merely comes from the Eastern Zone of Germany. Would some of the references have been given in a book published a few miles further west? It is a beautifully produced and exhaustive work on boilers, with admirable illustrations and a very long bibliography, and is typical of the best in German descriptive textbook writing. To the reviewer, however, one of the most fascinating parts comes on page 6, where there is a list of Germanised foreign words, and the German words which are used in their place. This takes us firmly back to the Nazi efforts of 1935 to purify the German language, and offers a very neat, although doubtless unintended, reminder of the great similarities to be found between Fascist and Communist ways of thought. What is particularly interesting about the list of words given is that where there is some sense in the change, the change has quietly taken place already; where the proposed change is mere pedantry, nothing has come of it except in books such as this.

Die Zahnformen der Zahnräder, by Hermann Trier, remains the best practical introduction to elementary gear geometry known to the reviewer, and is a little book published by Springer, better known for more formidable but equally commendable textbooks.

The elements of German hydraulic practice in machine design are treated in *Hydraulische Antriebe*, an excellent work, which has now reached its fourth edition. The authors, who are with the firm of Heller, have revised it thoroughly. The new chapter on electro-hydraulic mechanisms is rather thin, but there is much in the book to interest any machine designer.

D. B. WELBOURN

Weaving a Plausible Web

Synthesis of Linear Communication Networks. By WILHELM CAUER. Second Edition edited by WILHELM KLEIN and FRANZ M. PELZ. Translated from the German by G. E. KNAUSENBERGER and J. N. WARFIELD. *McGraw-Hill.* (151*s*)

Twenty years is a long time in the history of such an active field as network theory, and there are few works of which a translation so long delayed would be worth making at all. It must be said emphatically that this is one of the exceptions. The new publication has every merit of the first edition, completed in 1940, except that of having been written so long ago. Then, it was ahead of its time: now it is only up to date.

For this happy state there are two minor reasons and one major. There is a sense in which a sound piece of mathematical theory never dates: moreover, the editors of the second German edition and the present translators have added useful notes, references and an appendix on recent advances. But the most important factor is simply that Cauer was one of the handful of people who were working during the 1930's on topics which have only recently become the general currency of the engineer.

Virtually all of Cauer's many publications, from his doctoral thesis in 1926 to his last posthumous paper in 1951, deal with some aspect of network synthesis or filter design. Moreover, the discernment which rapidly led him to his fundamental approach to the problem was matched by his persistence in sticking to it.

Continued on next page

Campbell, Zobel and other pioneers had worked out the properties of specific filter sections and shown how to obtain useful characteristics by choice of parameters. Their methods are widely used to this day, and in no way does it belittle their achievement to point out the limitations: the use of image characteristics and lossless elements in the theory, the lack of any determinate means of meeting a specification, the redundancy of components in all but the simplest networks. Cauer's approach started with the question: what network characteristics are physically realisable? Given a desired characteristic which is not in this class, how may it be approximated by one which is? And, finally, when a realisable characteristic which meets the requirement has been found, what networks—in the plural, for there may be many equivalent configurations—may be used to realise it exactly?

Cauer brought to bear on these problems all the mathematical resources which have since been found the most fruitful: topology, function theory, matrix algebra. After an introductory summary, the book opens with a thorough and systematic treatment of general network analysis, the properties of two-terminal-pair networks, and network equivalences. The cardinal problem of realisability is discussed in great detail, in terms of positive-real functions and positive matrices; two appendices give a good outline of the mathematical techniques used. The treatment of filters falls into two parts. The image-parameter theory, despite the limitations noted above, has been and still is valuable for its relative simplicity, and its value has been enhanced by the extensive additions due mainly to Bode and to Cauer himself. The version in this book is notable for its systematic approach to the great range of possible characteristics, for the use of Chebyshev (" equal-ripple ") attenuation functions and for the charts and tables provided as aids to detailed design. The author's biggest innovation, however, is his theory of reactive networks working between resistive terminations with prescribed operating loss; this property differing only by a constant multiplier from the " insertion loss " more commonly used in English-language writings. Here the Chebyshev approximation is vitally important; both the analytical treatment, in terms of elliptic-function transformations, and the charts facilitating numerical design are thorough and clearly presented. In addition to the usual low pass, high pass and band pass filters, Cauer considers in some detail band-separation networks, which despite their practical importance are often ignored in textbook treatments. To this wealth of material the translators have added an appendix on recent advances giving a long and well-chosen list of references under five headings.

The book requires slow and thoughtful reading, but this is due to the extent and complexity of the subject matter rather than to any defects in the writing. A reviewer whose knowledge of German is no more than rudimentary can hardly allocate between author and translators either the praise for the general clarity of exposition, or the blame for occasional prolixity. The translators appear to be in no doubt that they have served Cauer very well. In one of the several prefatory statements (in which everybody thanks everybody else) they write: " A careful, tedious effort has been made to arrive at the cool lucidity of style which is customary in American textbooks, but on occasion style has been sacrificed to preserve original emphasis." This piece of individual and collective effrontery is an alluring target, but in justice any comment must be tempered by the recognition that the translators have laboured long and hard to make this valuable work accessible.

Although logically complete, this is not an introductory book, and the newcomer to network synthesis will learn much more rapidly from Storer or Guillemin. However, the engineer with a more than superficial interest in network theory will find it a gold mine, from which he cannot fail to gain information, enjoyment and a lasting respect for one of the great men of his subject.

K. W. CATTERMOLE

New Books

Symposium on Some Approaches to Durability in Structures. ASTM Special Technical Publication No. 236. *American Society for Testing Materials, 1916 Race Street, Philadelphia, USA.* (*Members* 82; *Non-members* 82·50)

Papers presented dealt with structural clay products, concrete, structural sandwiches, the effect of exposure to the atmosphere, and the durability of buildings—a subject which raises the designer's question, " How much durability do you want in a building? "

Laplace Transforms for Electronic Engineers. By JAMES G. HOLBROOK. *Pergamon Press.* (50*s*)

Unusually among textbooks this one sets out to provide for the practising electronics engineer who wishes to study in his leisure time, rather than attending an organised course.

Guide de Thermométrie. By CLAUDE GOUX. *Eyrolles, 61, boulevard Saint-Germain, Paris-V^e.* (2,600 *Frs*)

A handbook on temperature measurement, covering systems and scales, choice of method suitable for the particular case, indication and recording, and errors and corrections.

The Geology of Uranium. Translated from Russian. *Consultants Bureau, New York; Chapman and Hall.* (48*s*)

This collection of 12 papers published in Moscow in 1957 as *Voprosy Geologii Urana*, Supplement No. 6 of *Atomnaya Energiya*, presents recent Russian work in the field, and incidentally a summary article on aerial prospecting in the USA, Canada and Australia, with an appended list of 36 Western references.

Soil Mechanics for Railway Engineers. By U. G. K. RAO. *Railway Testing and Research Centre, Alambagh, Lucknow, India; The Office of the High Commissioner for India in London, India House, Aldwych, London, WC2.* (12*s*)

A combination of factors—heavy loads, high dynamic loading, and the serious consequences attendant on structural failures—persuaded the author of a need for such a book written specifically for the railway engineer. Sampling and testing, foundations, embankments, retaining walls, failures and stabilisation are covered.

Application de la Géologie aux Travaux de l'Ingénieur. By JEAN GOGUEL. *Masson et Cie, 120 Boulevard Saint-Germain, Paris-VI.* (4,300 *Frs*)

Geology applied to engineering by the French chief inspector of mines, who is also a professor at the Paris School of Mines, and Director of the French Geological Survey.

Handling and Treatment of Iron Ores. Special Report No. 65. *The Iron and Steel Institute.* (65*s*)

The proceedings of the Iron and Steel Engineers Group meeting held at Amsterdam in April, 1959, including papers on Dutch, Swedish, Canadian, United States and British experience.

Microwave Data Tables. By A. E. BOOTH. *Iliffe and Sons.* (27*s* 6*d*)

A collection of tables containing over 23,000 computed calculations, including decibel tables said to be the most extensive yet published. The binding of the volume is particularly strong and should stand up to a lengthy laboratory life.

Plastics Moulds. By R. N. B. MILLER. Machinery's Yellow Back Series No. 44. *The Machinery Publishing Co. Ltd., National House, 21 West Street, Brighton, 1.* (5*s*)

The design of injection, compression and transfer moulds for the production of plastic components is treated in the usual lucid and well-illustrated " Yellow back " manner.

Angus Gear Book. *George Angus and Co. Ltd., Angus House, 152-158 Westgate Road, Newcastle upon Tyne 1.* (15*s*)

A reference book produced by a leading manufacturer of machine-cut gears: the form of illustration and description is aimed at engineering students (to whom a 50 per cent discount is offered).

The Oil Engine World Directory of Manufacturers. 2nd edition. Edited by D. S. D. WILLIAMS. *Temple Press.* (7*s* 6*d*)

Lists the units offered by each company, with r.p.m., b.h.p. and number of cylinders. Introductory notes are given in English, French and German.

The Reviewers

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Mr. K. W. Cattermole, B.Sc., is laboratory head working on development of pulse communication equipment with Standard Telecommunication Laboratories Limited. He is the author of a recent book *Transistor Circuits*.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Handling

Electric Cranes. HERBERT MORRIS LTD., PO Box 7, Loughborough, Leicestershire. Electric overhead cranes up to 200 tons capacity. Examples of components and complete installations. Brochure, section 10, second edition.

Fork Trucks. RANSOMES AND RAPIER LTD., Waterside Works, Ipswich. Fork trucks 18/24 and 18/33, both for loads of 18,000 lb but at 24 and 33 in centres respectively; diesel driven. Double driving position, crane attachment. Illustrated leaflet.

Crawler Crane. N. C. K. RAPIER SALES CO. LTD., 32 Victoria Street, London, SW1. The Pennine crawler crane, fitted with booms up to 90 ft; diesel driven. Capacity at 75 per cent rating 9,000 lb at 25 ft radius. Leaflet.

Shop Crane. ALLAN LEVIN LTD., 21 Mackenzie Street, Slough, Bucks. The Nor-Vac hydro crane for shop use. Swivel castor at the back, twin wheels at front. Jib raised by central hydraulic cylinder, hand operated. Lift height 8 ft, width between legs 2 ft 4 in, capacity 1 ton. Leaflet.

Cage Winders. TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. LTD., Telcon Works, Greenwich, London, SE10. Winches and winding gear for mines. Folder.

Batching Plant. THOS. W. WARD LTD., Albion Works, Sheffield. Concrete batching plants for ready mixed, dry mixed and continuous applications. Fixed and portable types. Also fluidising pumps and conveyors. Booklet.

Hydraulic Platforms. HENRY SIMON LTD., Cheadle Heath, Stockport. Hydraulic platforms for rail, lorry or trolley mounting. Types and sizes in illustrated brochure.

Derrick Cranes. JOHN M. HENDERSON & CO. LTD., PO Box 26, Kings Works, Aberdeen. Derrick cranes of many sizes up to about 20 tons with 120 ft jib. Examples and details of construction given in coloured brochure.

Lift Trucks. MATBRO LTD., Fork Truck Division, Horley, Surrey. The Matbro series III fork lift trucks. Three sizes up to 8,000 lb capacity, all with very short turning radii. Leaflet.

Marketing

Australian Industrial Output Up 12 Per Cent

The AUSTRALIA AND NEW ZEALAND BANK's index of factory production shows a 12 per cent increase in the year up to October 1959. From a level of 100 in the year 1953-54, Australian manufactured output has now reached 150. The steady upward movement has owed much of its regularity to demand for consumer durables and there has been a strong contribution from transport equipment. Metals, machinery and apparatus have risen to a production figure of 149 from the base level of 100 and in furniture and household effects the level last October had reached 217.

A local tractor manufacturer competing with the British-made export reports turnover doubled since 1956. The company is CHAMBERLAIN INDUSTRIES LIMITED, of Welshpool, Western Australia, which has a capacity of 1,500 tractors a year.

The annual Australian market for tractors is estimated by the Australian Tariff Board at 18,000 and it expects this to rise to 30,000 within a few years.

GEC Contracts

Contracts worth more than £4½ million have been awarded to the GENERAL ELECTRIC Company for work at Ravenscraig for COLVILLES, at Newport, Mon, for RICHARD THOMAS AND BALDWINS, and for the supply of three auto-transformers for Canada.

The Canadian order is for three auto-transformers, worth £88,000, for the SASKATCHEWAN POWER Corporation.

For Richard Thomas and Baldwins, GEC will provide the main drives for the finishing train of the 68 in hot steel mill of the new Spencer works, at about £2¼ million. The contract for Colville's is for extensions costing about £2 million to the power house at Ravenscraig.

Benefits of an End To Price Fixing

The ordinary shopper would save a shilling in the pound from what he normally spends in the shops if price fixing were stopped.

This is the rousing conclusion drawn by Professor B. S. Yamey, of the London School of Economics, in his study *Resale Price Maintenance and the Shoppers' Choice*, published by the Institute of Economic Affairs (price 3*s* 6*d*).

That fixed prices discourage economical shopping, discourage competition and encourage the provision of largely unwanted "services" and too many employees in the distributive trades will be readily agreed. Professor Yamey cites the American case where a new car may be bought for up to 20 per cent below the makers' "advised" price. In Britain the makers can even get away with a stiff charge for driving the car along the road to the dealer.

According to Professor Yamey almost half of British consumer spending is in fields where all or some of the lines of goods in the particular field are price-fixed. The economies he predicts would come from greater efficiency in some shops and the closing of others.

At a time when labour shortage is appearing as the most likely single reason for delay in Britain's further industrial expansion it could be a healthy sign to see the largely underpaid legion of shop assistants shrinking away.

Undeveloped Markets in Central America

Mexico and the Republics of Central America had an import bill of £600 million in 1958—and the United Kingdom share of this was rather under 4 per cent. Less than a fifth of our proportion of world trade.

Mr. F. J. Erroll, Minister of State at the Board of Trade, returned at the beginning of the month from a tour of these areas and declared that he had seen and heard of scope for much wider British exports to these expanding markets. The Germans and Japanese were very active in making personal visits.

Mr. Erroll found that Mexico was moving forward very fast both in agriculture and industry. There was a definite demand for machinery and heavy capital equipment. While there is a tendency for infant industries to be protected by tariffs and import licensing arrangements the Mexicans are keen to see British firms opening local subsidiaries in liaison with themselves. There is no exchange control to retard remission of profits.

One British firm had licensed a Mexican concern to produce its goods. The Mexican company was now remitting more money in royalty payments than the British firm had earned before in direct exports.

In addition to Mexico Mr. Erroll also went to Costa Rica, Nicaragua, El Salvador, Panama and Honduras.

These states, he found, were feeling the effects of dependence on the United States, a high cost producer, and were ready to import factory equipment, machinery and capital goods from others. As markets for consumer goods they varied a good deal.

By the development of a Central American Common Market the disadvantages of individual small markets could be overcome. Factories for bottle making and paper and pulp are now being planned. An interesting opportunity exists in Panama where smaller road making equipment than the giant-sized American products is wanted for the construction of feeder roads.

Mr. Erroll referred to his Central American travels when he spoke as the guest of honour at the annual dinner of the Association of Consulting Engineers on 15 February. He made the special point—as the occasion demanded—that consulting engineers could do much to help manufacturers if they obtained work overseas. Mr. Erroll's remarks carried extra weight, and were particularly appreciated, because he is himself an engineer, with full membership of the Electricals and associate membership of the Mechanicals to his credit.

New Raleigh Cycle Subsidiary

The hand-built bicycles of CARLTON CYCLES Limited, Worksop, Nottinghamshire, well-known on cycle race tracks in this country and abroad, will continue to be manufactured following the take-over of Carlton by RALEIGH INDUSTRIES Limited.

In their statement the Raleigh company emphasise that the production of the Carlton cycles will continue as a separate operation at the Worksop factory. Not lending themselves to mass production methods the cycles will go on being "tailor-made."

A newcomer to the Carlton board will be Mr. Reg Harris, once the world cycling sprint champion and Raleigh's professional rider.

On Not Exporting to Sweden

The distributors with whom AB INTERPARES of Orebro, Sweden, are associated account for a yearly turnover of £16 million in building materials. Mr. Elof Elinder, managing director, who has spent 15 years with this wholesaling company, has not once been visted by a British exporter of materials.

Germans, Dutchmen and French exporters have called on the company, but never to his knowledge has a representative from the United Kingdom appeared in the office.

Writing in the *British-Swedish Economic Review*, Mr. Elinder points out that the volume of building materials bought in Sweden is a fifth of that bought in Britain. The UK cement consumption in 1958 was 11 million tons, in Sweden it was 2·3 million.

There are two important reasons that deter British exporters in this field, and Mr. Elinder gives them due weight. For a product with the low individual cost of most building materials transport charges rapidly assume an overwhelming proportion of the cost of the material arising on the site. The second is that keen price competition goes on between the Swedish home companies and profit levels there are often pushed down to very low levels, at which it becomes a very questionable undertaking to bring in outside materials.

Blithely stating that contracts between factories prevent competition ever arising Mr. Elinder applies this charge to cement, "many other building materials" and to linoleum.

For those undeterred by all this the likeliest development in British imports for the Swedish building trade would appear to lie with accoustic materials, floorings and in metal constructions. Central heating is almost universal in Swedish building and an obvious opportunity arises there.

There is a double challenge about this Mr. Elinder believes that Swedish building materials will be found attractive enough to be imported into Britain. And if the product can be sold in the tough Swedish market it should sell in other European markets.

In All Directions

Looking rather like a successful solitaire board the Transveyor is well known in many assembly plants and other works at the junctions of conveyor systems, as part of work benches or at packing or inspection points. It amounts to a system of 1 in diameter hardened steel balls, in cradles of 100 smaller balls, all housed in a hemispherical housing.

J. COLLIS & SONS, of Gray's Inn Road, London, the mechanical handling engineers, are now making their Transveyor in a larger size (2 in ball) for the rolling mills, shipyards, nuclear plants and heavy industry in general. The new all-directional assembly can be mounted on a small forest at individual stands to allow operatives to manipulate sheets and plates, or fitted into floors and behind the protective screens of the atomic plants.

Six New Viscounts

VICKERS-ARMSTRONGS have now sold 416 Viscount airliners, either the type 700 or later developments. The most recent contract has been signed with AUA (AUSTRIAN AIRLINES) for six Viscount V 810. Replacing and extending the previous AUA fleet of four Viscount 700's, the V 810's are to go into service from 1 April. AUA has been operating its Viscount fleet on charter from FRED OLSEN AIRTRANSPORT of Norway.

TI's Picture Exhibit at New York

TUBE INVESTMENTS' stand at the British Exhibition, New York, this summer, is to cover more than 3,000 sq. ft. Every aspect of TI's engineering, steel, aluminium and allied companies will appear and special emphasis will be laid on precision steel tubes.

Finished tubular products on show will include pressure vessels for industrial purposes, for the hospital and in the home, and controlled variations in tube wall from a universal joint coupling for a car to the compressor shaft of a jet engine.

Perhaps the largest photograph in the exhibition, of more than 200 sq. ft, will be that depicting a giant piercing press and push bench at one of the TI United Kingdom works.

Although ACCLES AND POLLOCK, a founder TI firm, now make over 2,000 shapes and sizes of tube, a filigree of 450 shapes and sizes exhibited by the firm at the New York World Fair, 1939, is to be shown again as a link with that TI visit.

Abadan and the Ruhr

BRITISH PETROLEUM have a 40 per cent interest in the Abadan refinery in southern Iran where a catalytic reformer costing £3¼ million is to be built over the next two years. The new plant is to produce high octane components and will be able to process a million tons of oil a year.

In the Ruhr a catalytic cracking plant is to be built at BP's new refinery, now approaching completion, at Dinslaken. The refinery is to be commissioned in June. The cracker will have a 10,000 barrel a day capacity.

A Special Purpose Adhesive Company

A new company of the EXPANDITE GROUP has been formed to manufacture adhesives for special applications.

The new subsidiary, EXPANDITE ADHESIVES Limited, will have its office and works at St. Helens, Lancashire. It is proposed to concentrate on adhesives for the building, civil engineering, metal fabrication and assembly industries.

Reactor Charging Machines

The machinery for loading and unloading the fuel elements at the Berkeley nuclear power station will be the first of its kind in the world to carry out these operations while the reactors are under power.

In order to make sure of the continuous generation of electrical power, the exhausted fuel elements at the Berkeley, Gloucester, nuclear power station must be immediately and safely replaced by new ones. It must also be possible for the control equipment to be withdrawn for servicing and an accurate assessment made of the future requirements of the reactors. In addition to being completely heat-resistant and pressure-tight, the machinery has to withstand gamma rays and be immune to neutron activity, in order to provide unfailing protection for the charge face operator. The fuel handling equipment, known as charge face machinery, designed and manufactured by John Thompson Ordnance Company, Ettingshall, Wolverhampton, fulfils these and other essentials.

The choice of material for making the machinery, and the production methods employed, created many problems. All materials must be compatible and difficulties were encountered with such items as rotating bearings. When welding the assemblies, the difference between stainless steel and mild steel in clearances had to be taken into account.

The accuracy with which the charge face machinery is made is illustrated by the services it must perform. Charge chutes, for instance, can select one of a possible 3,000 fuel channels, from a distance of 40 ft and to within 0·22 in.

The Berkeley charge face machinery consists in the main of the following items, Fig. 1:

Charge/discharge machines (2) and (7).
Chute machine (3).
Control rod and actuator servicing machine (CRASM) (10).
Support skirts (4).
Fuel loading conveyor (1).

The fuel handling equipment in Fig. 1 is shown with the flux scanning chute (6) and fuel charge chute (9) in their functional positions.

The charge/discharge machine is basically a winding mechanism controlling a grab which can engage a fuel element, as required, and is shown in Fig. 3 and as items (2) and (7) in Fig. 1. It has a rotatable magazine capable of accommodating 13 fuel elements, and also a reflector, a gag and a spare, and four concrete plugs to seal the chute. Below and above the magazine, shield plugs are fitted to reduce the effect of radiation; in the bottom plug is a rotary shield to seal off the channel used by the grab.

The reactor core is made up of 3,000 fuel channels formed in graphite blocks. In each channel, 13 fuel elements, resting on a deflector or dummy element and a gag, are fitted. The gag controls the quantity of CO_2 gas under pressure that can pass up a fuel channel, extracting heat from each fuel element as it passes by it. To provide continuity of heat output, the fuel elements, when nearing exhaustion, must be exchanged for new ones and variations in output may necessitate the replacement of the gag by one with a larger or smaller orifice. As the quantity of CO_2 that can pass through the reactor is increased, and as radiation harmful to human life is given off by the reaction in the reactor, this exchange of fuel elements and so on, must be carried out under working conditions by a machine that is itself enclosed in a pressure vessel and suitably shielded.

The charge/discharge machine can be used to discharge elements from the reactor into its magazine and from there, down the discharge well, to the disposal flask. In such circumstances it is a discharge machine. Internally, it may be highly contaminated so it is not normally used for any other purpose. The machine is used as a charging machine when it loads its magazine with new fuel elements from the conveyor (1) in Fig. 1 and afterwards charges, from this magazine, an empty reactor channel.

In order that it may operate, the machine must rest on a support skirt: the loading conveyor skirt, the discharge well or operating skirt. When not operating, the machine rests on a parking skirt. Basically, all skirts are similar, except in shielding properties and height. The machine weighs about 100 tons, and is lifted by crane from one skirt to another.

With the chute machine, shown in Figs. 2 and 4, various chutes can be placed in the reactor to bridge the gap between the charge face floor and the reactor pile.

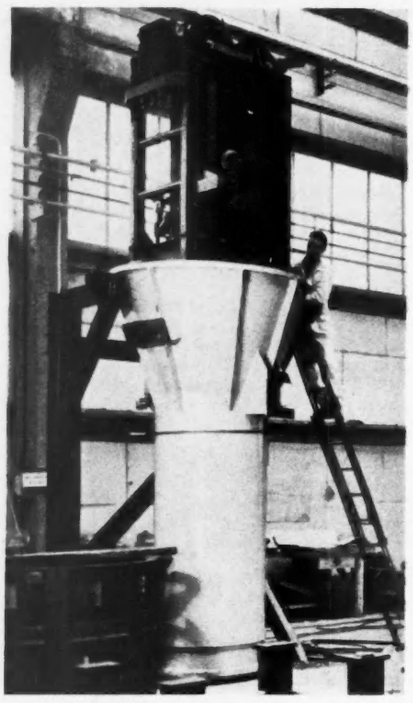


Fig. 2 The winding gear in the chute machine.

Two machines are supplied for each reactor charge face, but the spare replacement unit is not fitted with shielding. Because the chute machine operates with the reactor " on load," it includes a pressure vessel which can be connected to the reactor, via the standpipe. This vessel can withstand the reactor pressure. The shielding is fitted to protect the operators from radiation.

The equipment of the chute machine consists of a grab and winding mechanism to raise or lower the chute, a rotatable three-chambered magazine to store two chutes; a mechanism to

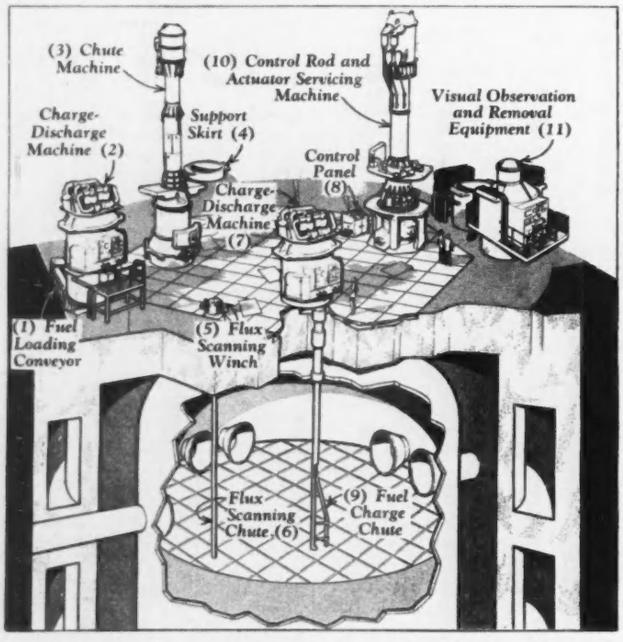

(3) Chute Machine
(10) Control Rod and Actuator Servicing Machine
Visual Observation and Removal Equipment (11)
Charge-Discharge Machine (2)
Support Skirt (4)
Control Panel (8)
Charge-Discharge Machine (7)
(1) Fuel Loading Conveyor
(5) Flux Scanning Winch
Flux Scanning Chute (6)
(9) Fuel Charge Chute

Fig. 1 Layout of the fuel handling equipment for the Berkeley reactor.

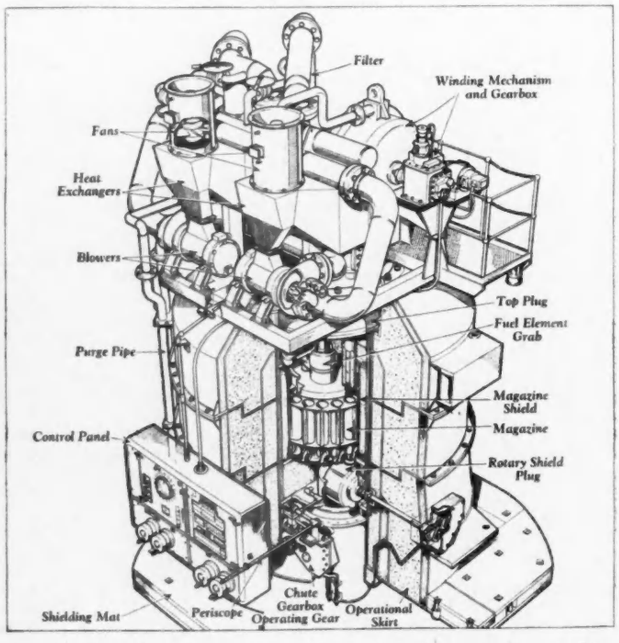


Fig. 3 The charge/discharge machine is basically a winding machine.

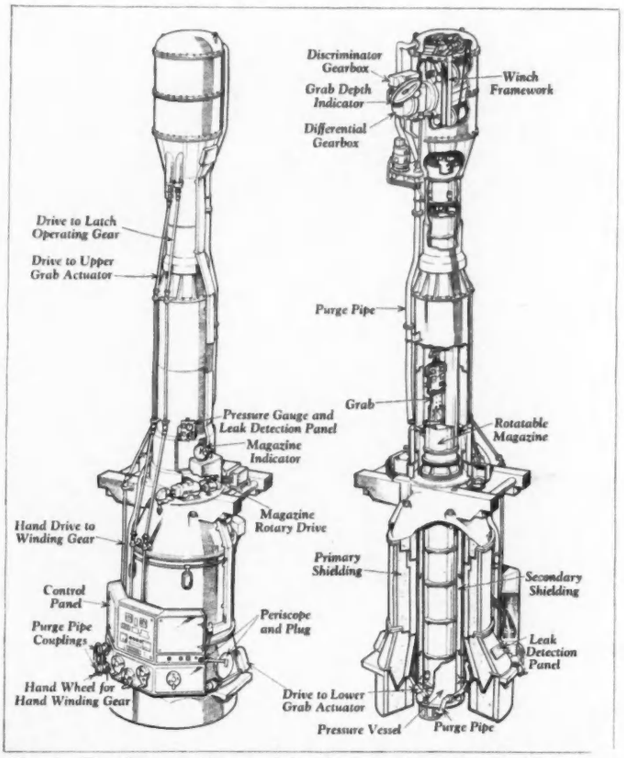


Fig. 4 The chute machine, used for placing various chutes in the reactor.

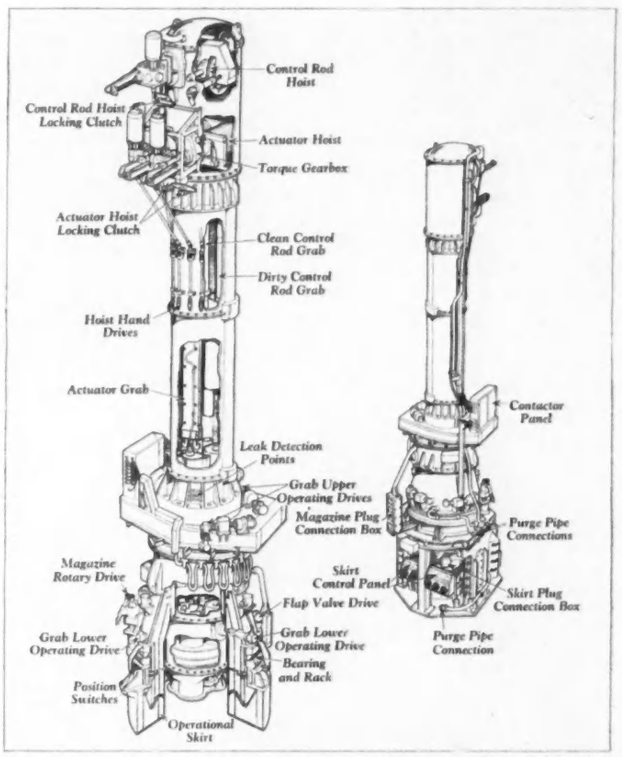


Fig. 5 Control rod and actuator servicing machine, referred to as CRASM.

operate the grab so that it connects with (or releases) its load and supports a released load in the magazine.

This equipment is contained inside the pressure vessel and on the outside are gearboxes to operate the equipment and to open or close the standpipe valve. A valve at the foot of the machine is fitted to contain the gas included inside the machine when removed from the standpipe. Facilities are provided for purging and pressurising the machine.

Outside the main shielding on which the pressure vessel is supported, is a control panel for operating the machine. To this panel are brought the drive shafts and electric leads, to cause movements to be made and thus indicate the state of the machine.

The chute machine is placed by the crane on an operational skirt when working over a charge point, over the inspection well, the discharge well, or the decontamination well. With the exceptions of the high parking skirt and the loading skirt, the machine can be placed on any support skirt. Electrical interlocks prevent lifting until machine and standpipe have been correctly prepared. Interlocks, all of which "fail to safe," also prevent incorrect operation of the machine.

The reactor contains a large number of control rods which can be lowered or raised from the graphite core as part of the reactor control system. Some of these control rods, the absorbers, are left permanently in place, but most of them are connected by wire cables to the electrical winches.

These winches, or actuators, are of about 15 in diameter, 12 ft long (including shielding plug) and weigh 15 cwt. Secured in the biological shield in specially-shaped standpipes, the actuators are in the pressure system. Screwed rings by which they are secured are turned by operating a motor and gear ring, known as the actuator clamping machine, which must be attached to the actuator during its removal or replacement in the standpipe. The control rod and actuator servicing machine, CRASM, is employed to exchange actuators, rods, gags, fixed absorbers, in the reactor, with spares. The complete unit consists of a magazine section containing grabs and their winding gear, and a support, or skirt section complete with various tools by means of which the actuator can be separated from, or connected to, its control rod. The skirt section is also used with the visual observation and recovery equipment when necessary. Both sections can withstand, either separately or together, the gas pressure in the reactor, and the operations of exchange can be performed while the reactor is on load. (See Fig. 5.)

About 40 ft high and 5 ft in diameter, the magazine section, together with its shielding, weighs 85 tons. It consists of a pressure vessel containing four magazines and associated equipment. Around the pressure vessel is fitted shielding in a structure by which the main crane can lift the complete unit.

The fuel loading conveyor (Fig. 6) is used for loading fuel elements into the charge machine and consists of a loading skirt, low pressure coupling, loading conveyor and its loader.

The conveyor consists of two horizontal endless chains passing around four sprocket wheels, each pair on a vertical axle. Supported between the chains are 16 compartments of approximately the same section as the tube used in the charge machine magazine. Stops fitted in the bottom of the compartment hold the fuel element, which is lowered into them by the loader, and raised from them by the fuel element grab in the charge machine. The spacing of the compartments is such that they extend over half of the conveyor only; when the first is under the skirt, the other is under the loader. Five spacers are fitted in the blank portion of the conveyor to maintain the correct spacing between chains.

Basically, the conveyor loader is a roller chain passing over a single sprocket wheel. In one end of the chain is a carrier and hook and, in the other a cylindrical balance weight. A handle turns the sprocket wheel via a spring-loaded clutch which prevents overload. To prevent the element from falling, under its own weight, into the conveyor this spring also loads a brake.

The loader casing is made up of one plain tube for the balance weight and another tube of the same section as those in the charge machine magazine; the latter tube is cut away to allow a fuel element to be inserted.

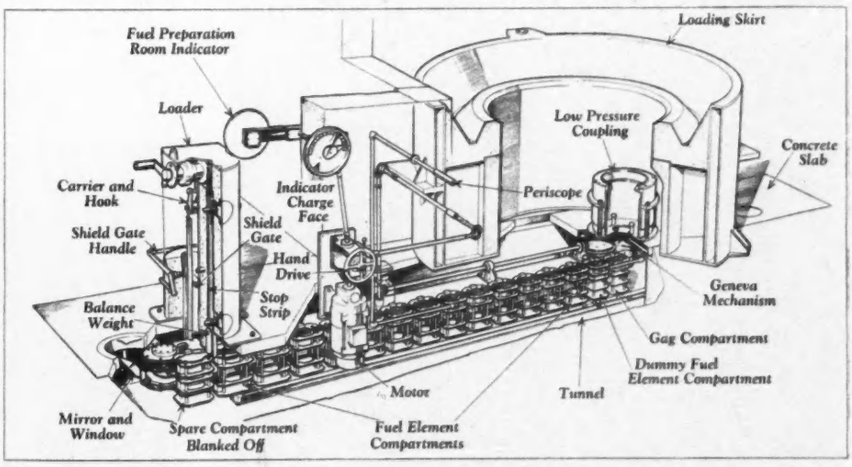
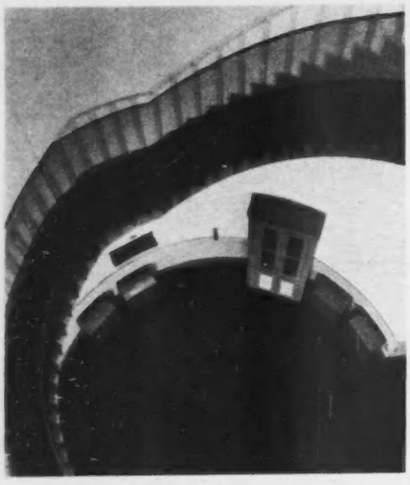


Fig. 6 Fuel loading conveyer that feeds the fuel elements into the charging machine.



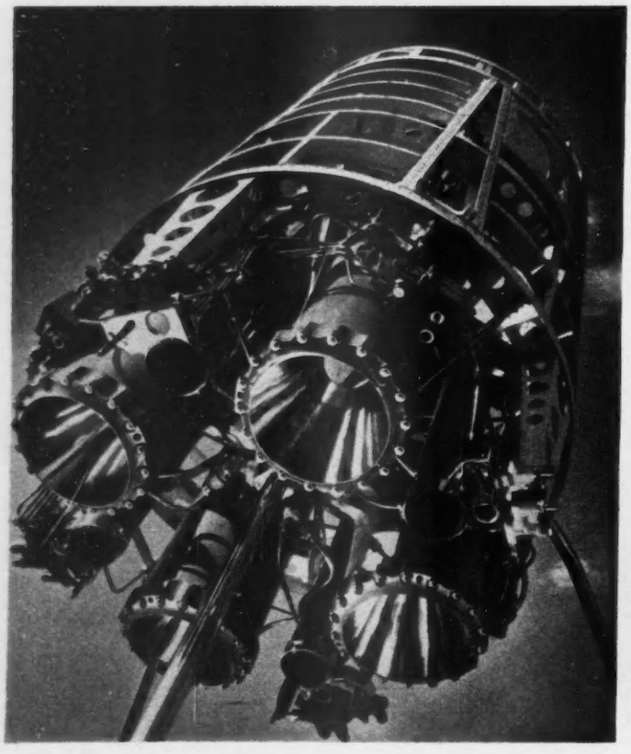
(Above left) Stationary baling with the David Brown 850 Implematic tractor and Albion baler.

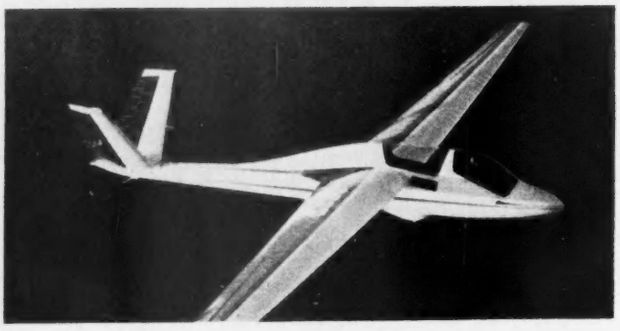
(Above right) Front view of the Leyland Firemaster for the City of Glasgow Fire Service, showing the pump deliveries and main control panel.

(Right) The Breguet 906 glider is a two-seater that recently made its maiden flight, and will be in production later this year.

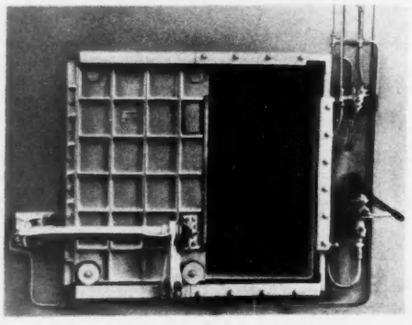
(Above) Nightstor heaters installed by the General Electric Company in the St. Mary's Island lighthouse (Scilly Isles).

(Below) Bristol Siddeley "Gamma" Mk. 201 rocket engine uses hydrogen peroxide as oxidant and kerosine as fuel.

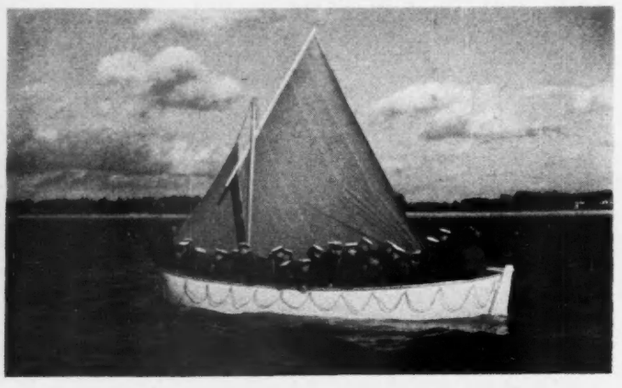




(Right) One of the Hyston water-tight doors made by J. Stone and Company, fitted to the P & O Canberra.



26 ft ship's lifeboat, built by Fairey Marine Limited, on trial in Southampton Water.



Direct Measurement of Tunnel Diode Characteristics

Tunnel diodes, which were invented less than two years ago, have developed so rapidly that difficulties have been met in finding techniques to measure their ever increasing characteristic speeds. At the Bell Telephone Laboratories in the USA, which is one of the main centres of tunnel diode development, new techniques have been developed for stabilising and evaluating the characteristics of these tiny devices. The same techniques have also proven successful for measurements on germanium and silicon diodes having time constants of the order of 10^{-9} sec, and on indium antimonide diodes having speeds several times faster. However, some of the new models now being devised at the Bell laboratories are so fast that they are beyond present stabilisation techniques. For instance, one diode has switched a quarter of a volt in a fifth of a millimicrosecond.

A tunnel diode, which is sometimes called an Esaki diode after its Japanese inventor, is a semiconductor device which exhibits a negative resistance region in its voltage-current characteristic. This negative resistance multiplied by the junction capacitance of the diode gives a time constant which is indicative of the relative merit of the device. In general, a smaller time constant corresponds to an increased figure of merit.

In order to make direct measurements of the negative resistance and junction capacitance the diode must first be stabilised in the negative resistance region. This can be done by shunting the diode with a resistor. Since inductance in the resistor leads can cause instability, these leads must be made as short as possible. In order to measure the negative resistance characteristics of the diode, the shunt resistance is made equal to, or smaller than, the negative resistance of the diode. If the series inductance in the circuit connecting the shunt to the diode is small enough, the combined diode and shunt will show a voltage-current curve which is stable and positive over the entire voltage range of the diode and which can therefore be plotted. If the voltage-current characteristic of the shunt resistance alone is then plotted, and manually subtracted from the total curve, the characteristic of the diode can then be obtained.

These "characterisation" methods are said to have been extremely helpful in research and development efforts aimed at improved diodes with ultra high speed characteristics.

Techniques now exist for measuring the negative resistance of high speed tunnel diodes. The characteristic can be plotted automatically on the instrument.

Low-Speed Wind Tunnel Tests

A report has been issued which contains the results of low-speed wind-tunnel tests of longitudinal stability of a modified Sea Venom Mk 21, with blowing over the flaps. The report states that at each flap angle a range of values of the sectional momentum coefficient was tested. As a typical example, the increase in trimmed coefficient of lift, C_L, at constant incidence resulting from blowing at flaps 60° was about 0·45, the increase in C_L maximum being somewhat smaller.

The equivalent reduction in approach speed of 10 to 15 knots predicted from the tunnel results was later achieved in flight. The tunnel results also suggested a beneficial reduction in minimum-drag speed due to blowing, particularly at large flap angles. Trim changes were large, amounting to about 8° on the all-movable tail at flaps 60°.

A comparison is made between estimated and measured effects of blowing. It is shown that, while the lift and pitching moment increments resulting from flap blowing can be estimated fairly closely, the drag increments at large flap angles are much larger than would be expected. The additional drag tends to decrease the minimum-drag speed and increase the minimum drag. The report, *Low-speed Wind Tunnel Tests on a Sea Venom (Mark 21)*, is issued by HM Stationery Office London, at a cost of £1.

Longer Life for Electronic Valves

Valve reliability and lifespan have always been major problems facing the designers of electronic equipment. However, in recent years it has become known that the life of valves can be very considerably improved by lowering the temperature of the glass envelope, without in any way imparing the performance.

In previous times, due to lack of this knowledge, valve shields were always designed to give mechanical support or electromagnetic screening without consideration of temperature. Consequently, the valve's ambient temperature was often increased, to the point that early failure was precipitated.

The problem of designing and developing a valve shield that will adequately retain, effectively shield and efficiently dissipate heat from a valve has now been overcome by engineers of the United Kingdom Atomic Energy Authority at Aldermaston. Several prototypes have been successfully tried and the design is said to be suitable for mass production.

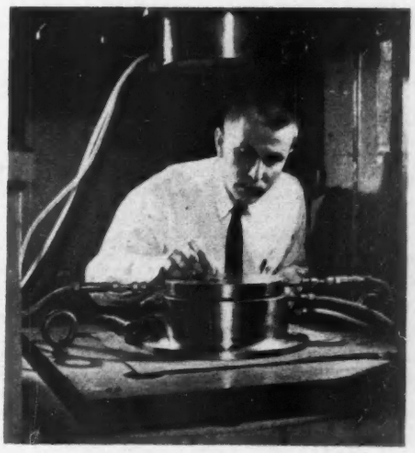
Initial tests have indicated that the new shields are capable of reducing valve bulb temperatures under certain conditions by some 90° C. Compared with the best commercially available shields, either here or in America, the new shields show an improvement of about 30° C in the operating temperature of the valve. The cans are made on the lines of nuclear fuel containers.

Materials at High Pressure

Under contract for the US Atomic Energy Commission, workers at the structural chemistry division of the Battelle Memorial Institute have been investigating hitherto unexplored effects of extreme pressure and heat on materials. The main study carried out with this apparatus to date has been on the uranium-oxide system. Such studies are a prerequisite for the evaluation of the effects of high pressure and temperature on the reactions of various oxides with uranium oxides. One outcome of this study so far has been the discovery of a new uranium oxide, gamma U_3O_8. In general it has been found that combined heat and pressure effect the reduction (in oxygen) of the higher uranium oxides to structures having greater density.

When a specimen is placed in the apparatus and the die is closed under pressure, it becomes subjected to a pressure of over one million pounds per square inch at a temperature in excess of 2,000° C. In some instances pressures of the order of two million pounds per square inch have been obtained.

This combination of heat and pressure simulates an age old process in nature—the formation of minerals and gems in the earth. The pressure-temperature combination attained at Battelle approximates conditions at a depth of 200 miles below the earth's surface, where diamonds are believed to have their origin.



In this apparatus, a specimen can be subjected to a pressure of one million lb per sq. in, at a temperature of over 2,000° C.

Molecular Electronics — A New Concept

Electronic equipment has an evolutionary tendency to get smaller and smaller. Now intensive research has lead to the possibility of electronic equipment being made on a microminiature scale.

It was just over ten years ago that the transistor emerged from the research laboratories and brought with it a new concept of electronics—the solid state device. At that time obvious advantages could be seen for these devices and considerable use has since been made of them. However, the final outcome could not then have been visualised, and even now an extensive imagination would be needed to foresee all the possibilities of these remarkable components.

The first obvious advantage of the transistor was a valuable saving in weight and size, compared with the thermionic vacuum valve. However, it was not until later that the other major advantage, reliability, was realised.

Since these features—reduction in size, reduction in weight and improved reliability—were precisely the requirements of the military and space research authorities in the USA at that time, it is not at all surprising that American research in this field has been pushed forward at a phenomenal rate.

Many outstanding results have already ensued from this all-out research programme and many more are expected to follow, but few can be envisaged that will have more far reaching effects than the new circuit concept known as " molecular electronics."

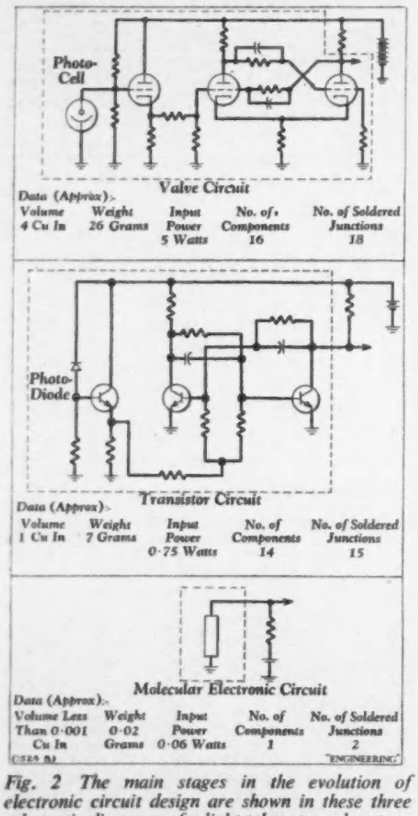


Fig. 2 The main stages in the evolution of electronic circuit design are shown in these three schematic diagrams of a light telemetry subsystem. At the top the circuit is shown in what might be called yesterday's concept, using valves. In the middle is today's, using transistors. At the bottom is tomorrow's concept—the entire circuit replaced by a single solid state " device."

Smaller and lighter components in more compact packages can always be obtained by conventional means; but such techniques do not yield maximum reliability. On the contrary, when an emphasis is placed on size and weight reduction it usually means that components and internal connections become so critical that they must be made within unrealistically fine tolerances. As a result of this, a substantial amount of research and development effort has been focused on to other means of achieving these aims. So far this research has opened up more than one promising avenue of approach but molecular electronics, which has been reported by the Westinghouse Electric International Company of America, is one that seems to have particular promise.

SOLID STATE CIRCUITS

This is an entirely new concept of electrical engineering, which gets its name because of its dependence on phenomena occuring within or between the domains of molecules in the solid state. Briefly, the main feature of molecular electronics is that whole circuits, such as oscillator circuits and amplifier circuits, can be made in one small piece of solid state material. This means that instead of an oscillator being made up with valves, resistors, inductors, capacitors, and so on, all wired together, an equivalent circuit can be formed in one small, multi-zone crystal with simple input and output terminals.

As a result of a joint development programme between Westinghouse and the Wright Development Centre, Westinghouse are now producing a number of these molecular electronic " function blocks," three of which are shown in Fig. 1. These are solid state elements that achieve, entirely within themselves, electronic results such as have been previously obtained only by assembling a number of various components. Because of this, these elements cannot be considered as mere components, such as transistors and valves, but rather as subsystems.

Because there are no internal connections or components and the only external connections needed are those to couple inputs and outputs to the complete system, subsystems can be built whose risk of failure should be equal to or less than that of familiar solid state devices. This means that when a conventional circuit, containing many components and a number of soldered joints, is replaced by a solid state molecular electronic subsystem the relative risk of failure may be only one in a thousand. This represents an improvement in reliability of three orders of magnitude, which is accompanied by a volumetric reduction of similar order and a weight reduction of about two orders of magnitude.

Fig. 2 illustrates the ability of molecular electronics to reduce the number of components and connections in a practical circuit (which is a light telemetry subsystem). When designed to use thermionic valves, this subsystem required 16 components and eight soldered connections; when designed to use transistors it required 14 components and 15 connections. In complete contrast, when designed as a molecular electronic subsystem, achieving the same purpose, only one component and two connections were required.

It is now known that, as a result of the joint Westinghouse and Wright programme, eight classes of function blocks have been made which have amply demonstrated the feasibility of molecular electronics, at frequencies ranging from infra red to direct current. These are: a five watt directly cascaded audio amplifier; a frequency selective amplifier with notch filter in a feedback loop around the amplifier structure; a variety of multivibrators—monostable, bistable and astable; a variable ponteniometer based on logarithmic addition of two inputs; a variety of multiposition switches; an analogue to digital converter employing an n-p-n-p relaxation oscillator; and a two-stage cooler using the Peltier effect, covering frequencies from 1 c/s to 3 Mc/s, for cooling infra red detectors to correct operating temperatures.

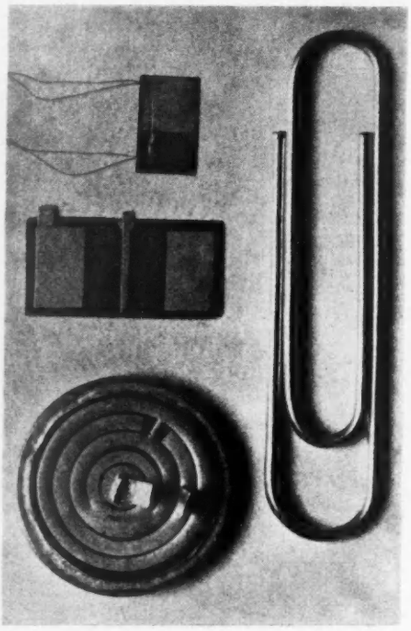


Fig. 1 Three " molecular electronic function blocks beside a normal paper clip. At the bottom is an audio amplifier; in the centre is a free running multivibrator; and at the top a two-stage video amplifier.

Westinghouse, who have long been in the forefront of solid state research, have all the facilities for creating materials having excessive positive or negative charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification and amplification (as in diodes and transistors). In addition to this they are able to take advantage of nuclear radiation phenomena which cause charge paths to occur in semiconductor materials, allowing current to flow when the material is irradiated.

CRYSTAL DOMAINS

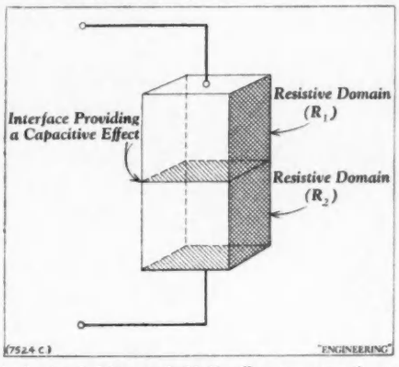
Effects of this general type are used in molecular electronic blocks by creating a number of distinct operating domains usually in single crystals. These domains have been described by Dr. S. W. Herwald, Vice-President of Westinghouse Electric Corporation, as " molecular communities having a common civic purpose in that each domain will sustain a desired electronic occurrence." These domains, says Dr. Herwald, " border one another at boundaries called interfaces which are like political frontiers in their ability to initiate phenomena different from those occurring inside the molecular domains." For example, take an element composed of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the flow of current; the other domain is also resistive, having a value R_2. At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element there exists a subsystem equivalent to a capacitor-resistor time delay circuit.

Another illustration of the uses of domains and interfaces is a function block designed as a rectifier power supply for transistor circuits. It makes use of the Seebeck effect for the conversion

of 110 volt alternating current to 9 volt direct current power. In contrast to it, the conventional circuit (see Fig. 5) requires five individual components—a transformer, a diode and capacitive and inductive elements which go to make up an inductor-capacitor (LC) filter. To obtain the same purpose by molecular electronic methods all that is required is a function block composed of three separate domains. When a.c. power is applied to the resistive domain, the heat generated passes through the centre section—which is an electrical but not a thermal insulator—and into the thermoelectric domain where the thermal energy is converted into d.c. power by the Seebeck effect. By proper control of the materials used, the required 9 volts ouput can readily be achieved. Since thermal inertia is high in the centre domain, the d.c. output is relatively free from unwanted ripple.

As these two examples suggest, the concept of molecular electronics makes no use of the traditional circuit and component approach to electronics. Instead, the objective is to use the solid state physicists knowledge of the structure of matter to synthesise monolithic function blocks whose arrangement and composition permit each to serve as a substation to perform an electronic function in the control or transformation of energy.

To achieve function blocks with this capability, a number of effects and phenomena known to the solid state physicist are available. The only firm limitations on choice are that the effect must not react adversely in relation to the overall system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include:



Seebeck, Peltier and Hall effects; use of p-n semiconductor junctions arranged to produce a result which would otherwise require numerous individual components; and, when necessary fabrication of circuit elements within a function block. Although such phenomena are most likely to be used for the control of electrical signals, they are also suitable when quantities such as electromagnetic radiation, heat and mechanical displacement are to be the inputs or outputs.

At Westinghouse, the design of a subsystem begins with an analysis of the requirements of the system to establish the functions to be performed. After logic processes are determined and suitable physical effects decided upon, a mathematical physicist determines the structure of the block by designing, on paper, the arrangement of the domains and interfaces that are to control the flow of energy in the block. The block is then produced by the materials engineers, using germanium and silicon as basic materials.

These function blocks are not assembled from smaller components, at least not in any ordinary sense. Instead, they are formed from a basic semiconductor wafer, on which the necessary domains and interfaces are produced by conventional semiconductor techniques such as diffusing, plating, electron beam etching, cutting, irradiating, alloying and various photographic processes. Although the block so produced can then perform its function, further processing is required to encapsulate the block, protect it against shock and vibration and make it stable under the conditions of temperature and radiation that it may have to encounter.

DENDRITIC PROCESS

From the very nature of molecular electronics, it is clear that the materials physicist plays a vitally important role. An illustration of this can be seen in the development of a method for the rapid production of semiconductor crystals in a form that requires no removal of material to make them into suitable wafers for use as transistors or as the basic elements of molecular electronic blocks. This is the dentritic process, announced several months ago by Westinghouse, in which germanium crystals in the form of ribbons about one eighth of an inch wide and a few thousandths of an inch thick, are produced by drawing them from a molten mass. In contrast to this, the conventional method requires germanium crystals to be grown as thick ingots, requiring X-ray or crystallographic inspection before they can be sawn into precisely oriented wafers, which must then be lapped, polished and etched to obtain a satisfactory working surface. In addition to the waste of material and the cost of machining involved in the standard method, a serious disadvantage to its use for the production of molecular electronic blocks is the wide variation in characteristics frequently displayed by wafers, even when cut from adjacent regions of a single crystal and processed in an identical manner. In the production of ordinary transistors this difficulty can easily be circumvented by test selection at the end of the production line. However, in molecular electronics it is necessary to build junctions in adjacent portions of the same crystal; thus, if the yield is to be acceptable, it is essential to have materials whose characteristics are uniform.

The main advantage of the dendritic process may be summed up as follows. It is essentially a continuous process in which the germanium ribbon grows at a rate of 6 to 12 in per min and in the precise direction of crystal growth required for application. Thus, no X-ray or crystallographic examination is necessary and the surfaces of the ribbon are always correctly oriented, optically flat and immediately usable as working surfaces. An additional advantage is that, if a contaminant enters the melt during the process, the resulting inclusion is " self-healing " so that when the process is completed, the affected portion can be cut away and the unaffected portion put to use.

Although the dendritic process has immediate use in molecular electronics, it is believed that its greatest significance lies in its ability to bring about a number of completely new processes for producing function blocks. Considerable interest has been aroused by a recent modification to the process which makes it possible and practical to carry out diffusion, plating and evaporation processes directly on the crystal as it grows from the furnace melt. With this technique it is possible to create semiconductor devices ready for the immediate attachment of leads. One of the first uses has been to grow transistors in the form of a long crystal.

HIGH PRODUCT YIELD

When ribbon-like crystals are cut into segments, only simple processing is required to produce transistors at a yield of almost 100 per cent. By this method Westinghouse have produced lengths of ribbon along which small multiple-junction subsystems are distributed (Fig. 4). Since these ribbons can easily be processed to become a long series of tiny amplifiers, it is conceivable that the ribbon could ultimately be cut into various lengths to give whatever stage gain is required.

One of the most recent achievements resulting from development of dendritic techniques has been the discovery of a method by which multi-zone crystals can be grown as dendrites directly from the furnace melt. This new technique makes available function blocks having at least three layers of zones and two interfaces without the necessity of a number of separate operations.

In considering the implications of this basic method of crystal growth, one interesting possibility that arises is the feasibility of combining the ability to grow multi-zone crystals with the ability to perform operations on the crystal at the time it is growing in the furnace. Although the automatic production of semiconductor devices and molecular electronic function blocks must be a long range objective, it is not improbable that it will eventually be possible to actually grow electronic equipment, of the order of complexity of a radio receiver, from a pool of molten materia[1]

Fig. 3 (Left) This very simple " molecular electronic function block " constitutes a complete time-delay circuit by virtue of its capacitance and resistance.

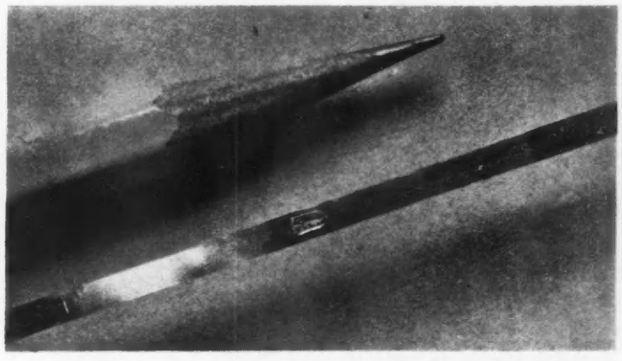


Fig. 4 (right) A recently developed technique enables multi-junction subsystems, with very minute dimensions, to be produced on a length of ribbon.

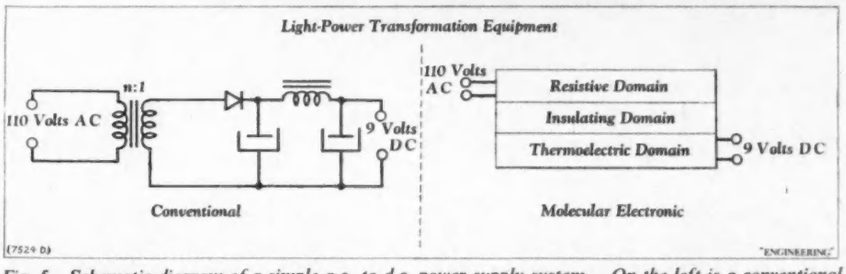


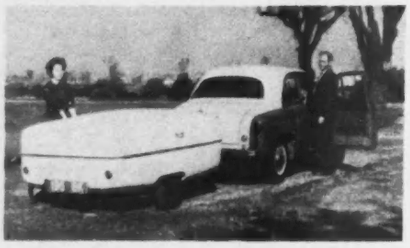
Fig. 5 Schematic diagram of a simple a.c. to d.c. power supply system. On the left is a conventional circuit, using transformer, rectifier and LC network filter, for smoothing the output. On the right is an equivalent molecular electronic circuit, where a resistive molecular domain is heated by a.c. input, giving rise to a smooth d.c. output in another (thermoelectric) domain.

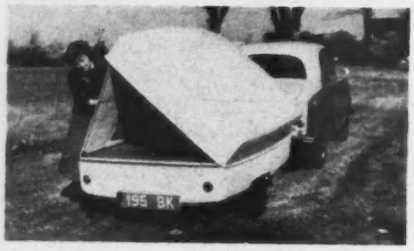
Home Comforts Abroad

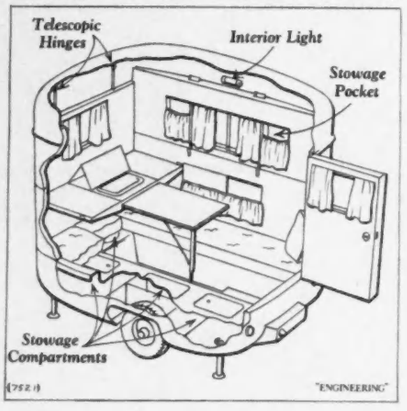
Gradations in camping must be as numerous as campers. There are those who like to rough it, those who demand caviar and feather beds, those who join groups at camping sites and those who sleep alone in the wild hills. In between, come the scores of ordinary folk who prefer caravans to tents and are content with a modicum of comfort.

The number of caravan types is also great, ranging from the converted bus to the lightweight trailer. The majority, however, fall into the towed vehicle class. Of recent development, and probably to keep pace with the growth in the popularity of small cars and "bubbles," there have appeared caravans that fold flat to form lightweight trailers which, at a pinch, can be hauled by motor cycles. One of these is the Mini-Motel illustrated here.

As a trailer, the Mini-Motel measures 8 ft 4½ in long, including the 17 in tow bar, by 4 ft 9½ in wide and 3 ft high. The weight is 500 lb. To convert it into a caravan, each side of the roof is lifted in turn and the folding sides are pulled out and locked in place. The end panels, which are fixed to the roof by telescopic hinges, are then swung down into position. The height of the caravan is thereby extended to 6 ft 2½ in. For its size the accommodation is remarkable, for there is room for two adults in single berths and a small child in a cross bunk. Alternatively, a double bed can be formed across the whole of the interior.







Erection of the Mini-Motel is one man's (or woman's) work. The roof is lifted and each side pulled out in turn. The ends hinge down from the roof. The sleeping accommodation is sufficient for two adults and a child.

The bodywork is made entirely of glass fibre. Across the bottom is a single steel member that carries the Flexitor rubber mounts for the wheels, which are 8 in diameter with Dunlop two-ply by 4 in tyres in the standard model; four-ply tyres are also available. Virtually the only other pieces of steel in the caravan are the towing bar, which is made up of two 2 in by 1½ in channels bolted to glass fibre webs, and the four jacks for steadying the corners when set up on site. An alternative version has three jacks only.

The walls and door are double skinned with ribs between for strength, and the roof is a one-piece moulding. The base with the seats, lockers, and centre well is a single moulding and is therefore water tight. A plug in the centre well is fitted for drainage and allows this portion to be used as a bath by the really luxurious camper. A plastic bowl is included in the table that folds against the front wall. It is this table that is used as the bunk for the third member of the family. An extension table can be fitted over the well for meals and general use.

Sliding windows, measuring 31 in by 10 in, are fitted in each side wall and fixed windows of 21 in by 10 in in the rear door and front wall. Two base boards fit over the well to make up the double bed which is completed by six cushions that fit between the two Barafoam mattresses on the side berths. The completed bed is 4 ft 6 in wide. Additional cushions are used to make up the child's bunk on the cross table.

The main stowage compartments are reached through panels under the seats, and there are pockets in the sides for small items. Provision has been made for fitting a gas cooker on the front table and the caravan can be wired and fitted for interior lighting from either 6 or 12 volt supplies. It is supplied complete with road lights, brakes, and plug-and-socket connection for attaching to the towing vehicle. When not in use the Mini-Motel can be stored on its side in the garage, thereby reducing very considerably the floor space required. The glass-fibre construction brings with it all the inherent advantages of no painting, no rusting, no rotting, and ease of repair in the event of accidental damage.

Although cookers running from bottled gas supplies have been common for some long while, a refrigerator that does the same is a much newer thing. The Mini-Rex is such a unit and surely brings the last touch of comfort to the camp. It measures 20 in by 16 in by 17 in outside and has a capacity of 1¼ cu. ft. The weight is approximately 30 lb. It works, of course, on the absorption system which has the advantage in this instance of no moving parts and small consumption. A standard 12½ lb bottle of butane or pentane will run the refrigerator for 30 days continuously.

The casing is made of high impact polystyrene and the walls are insulated with Tempex. Inside, there are two wire shelves, a drip tray and an ice cube container. An adjustable thermostat gives running temperatures from 0° to 7° F below freezing. An alternative version is made which will run from either a battery or from the mains; in this model the consumption is between 25 and 35 watts.

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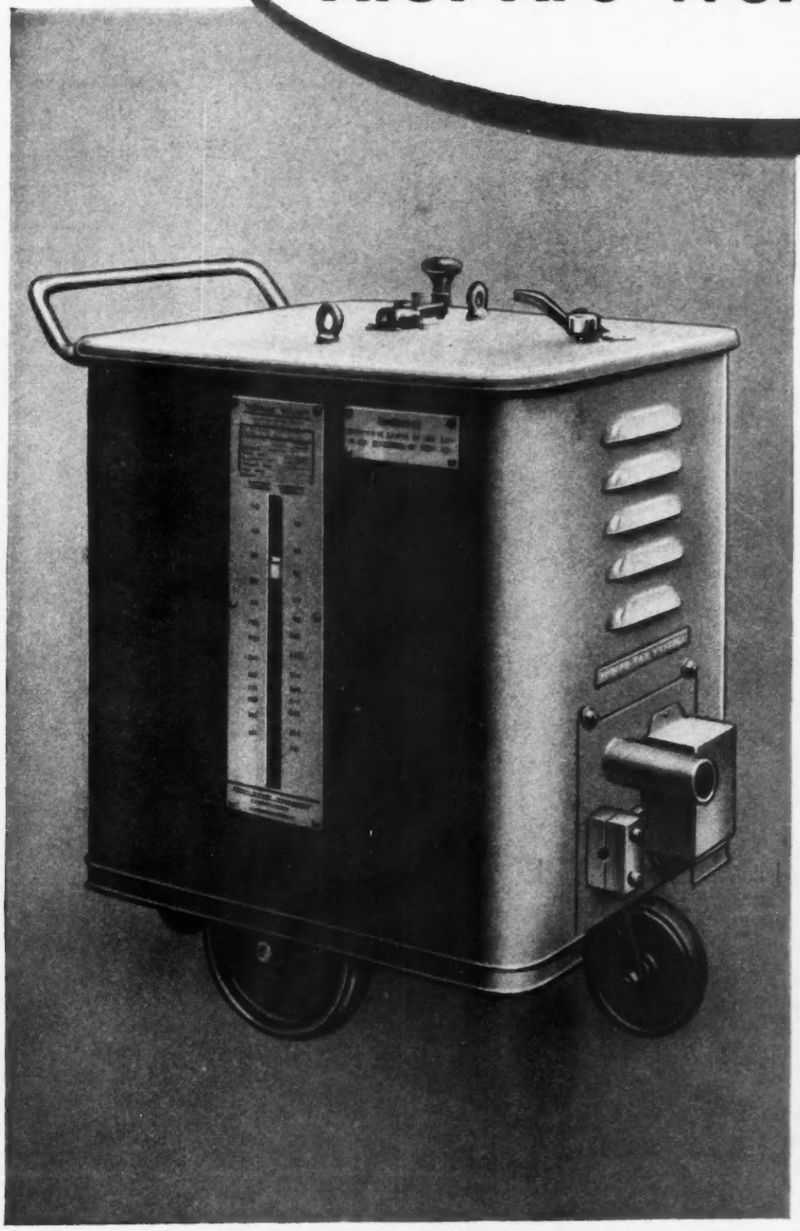

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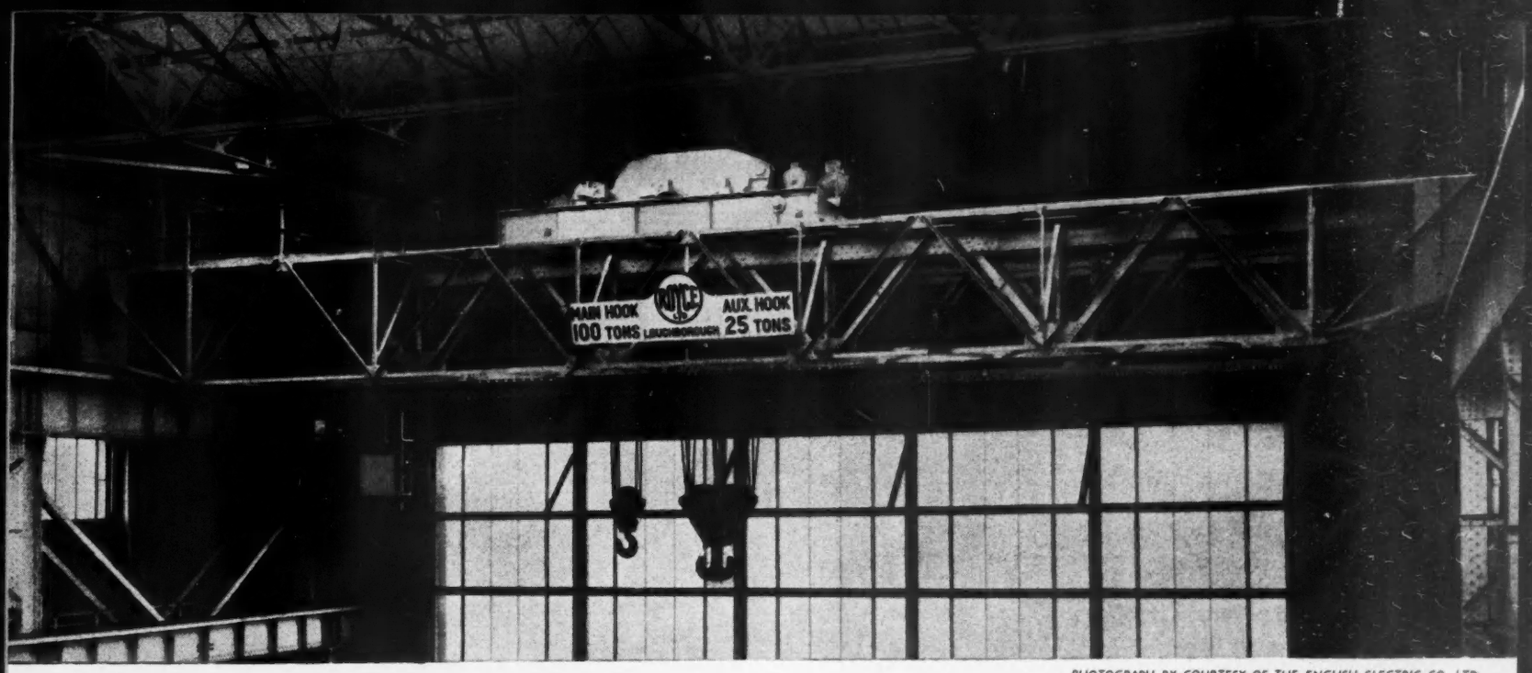

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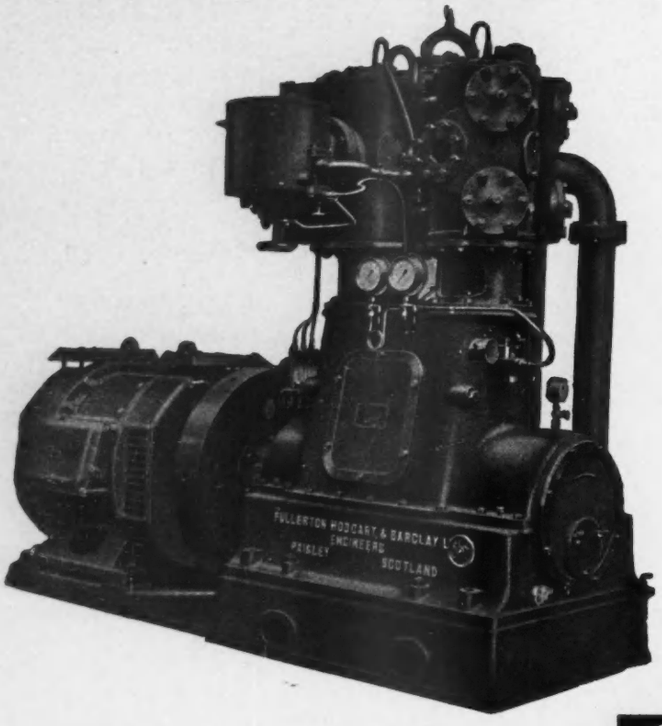

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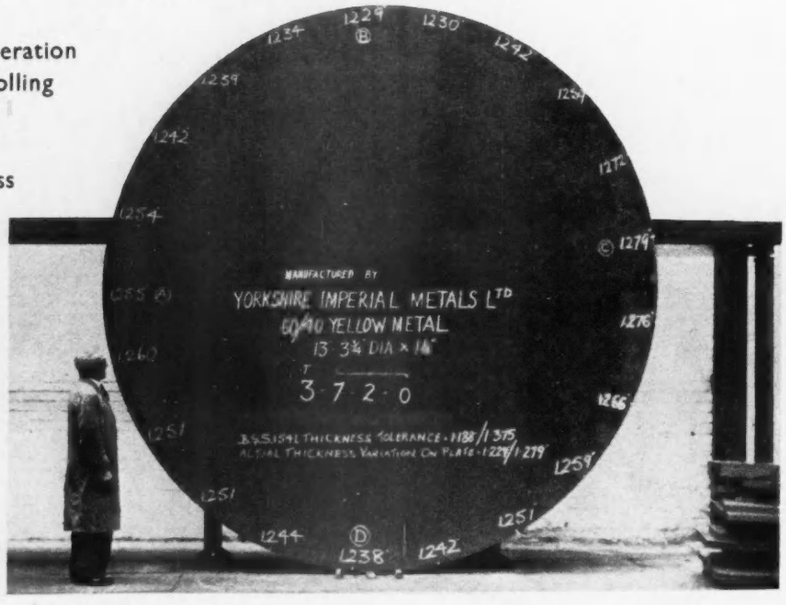

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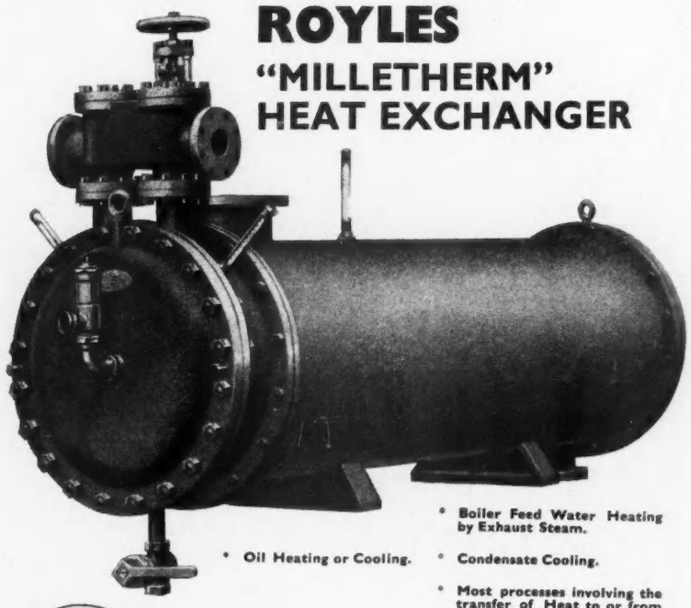

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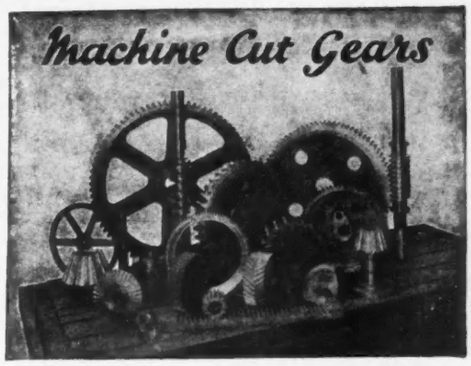

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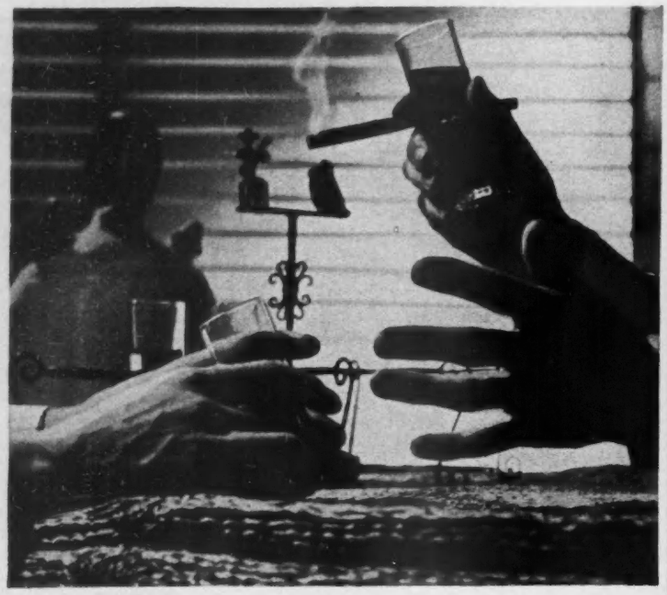

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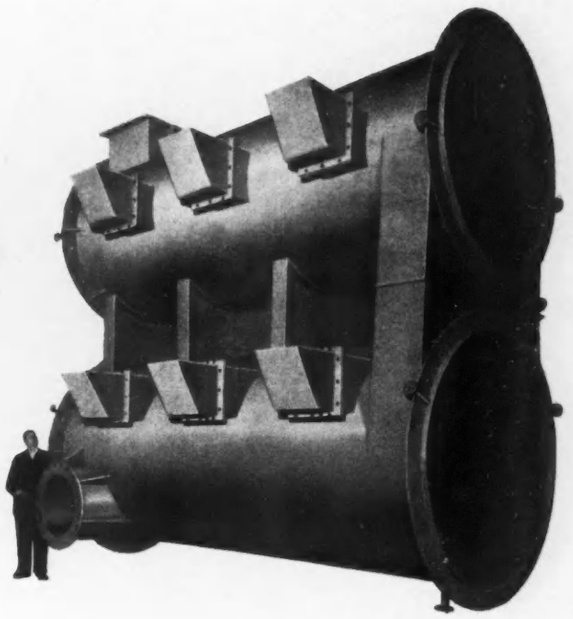

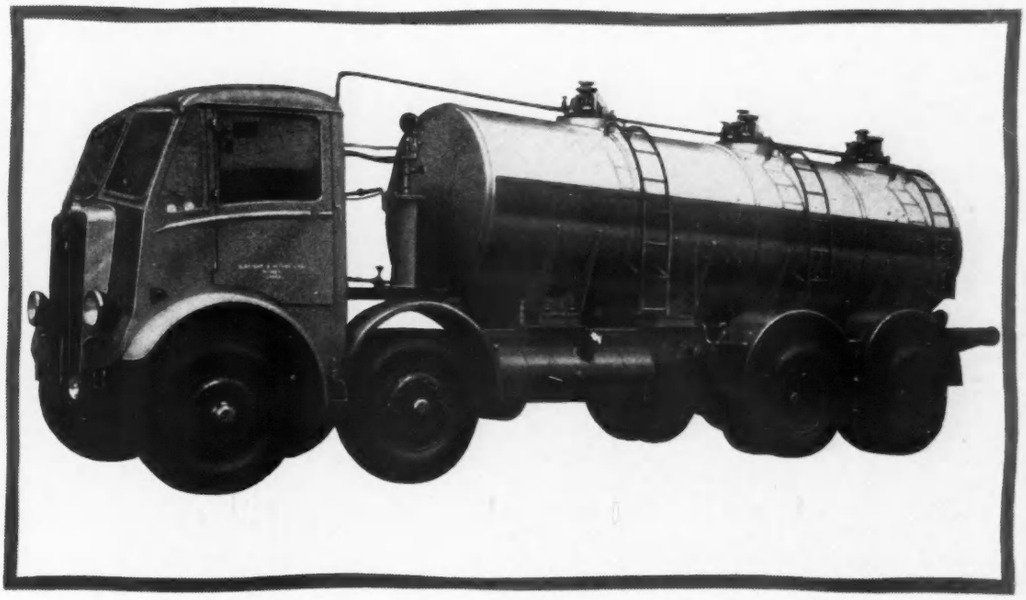

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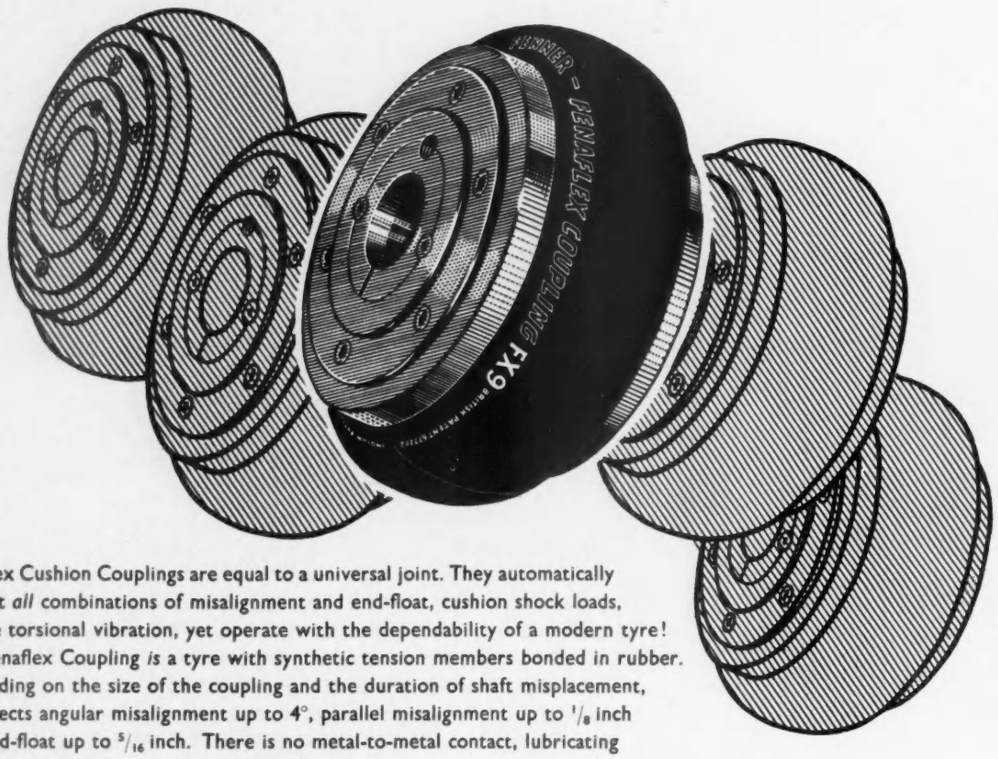

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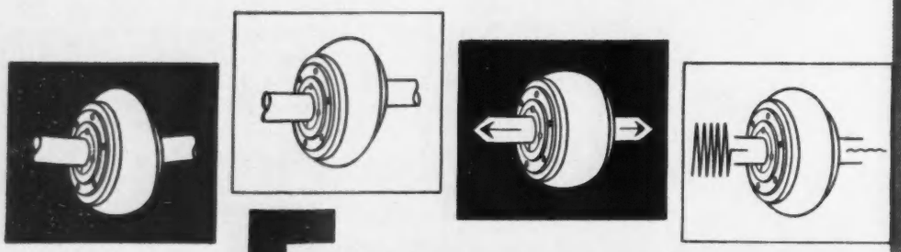

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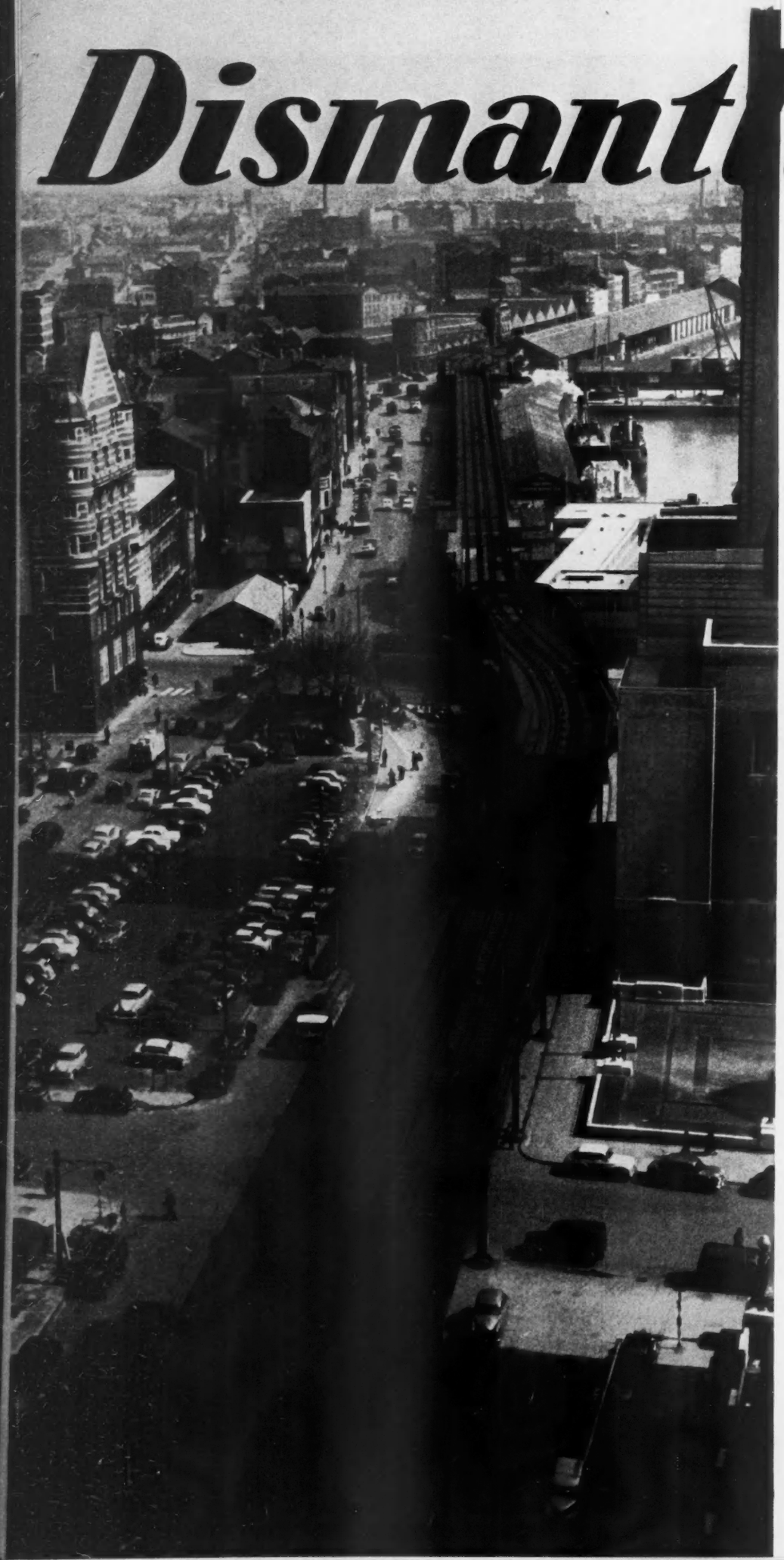

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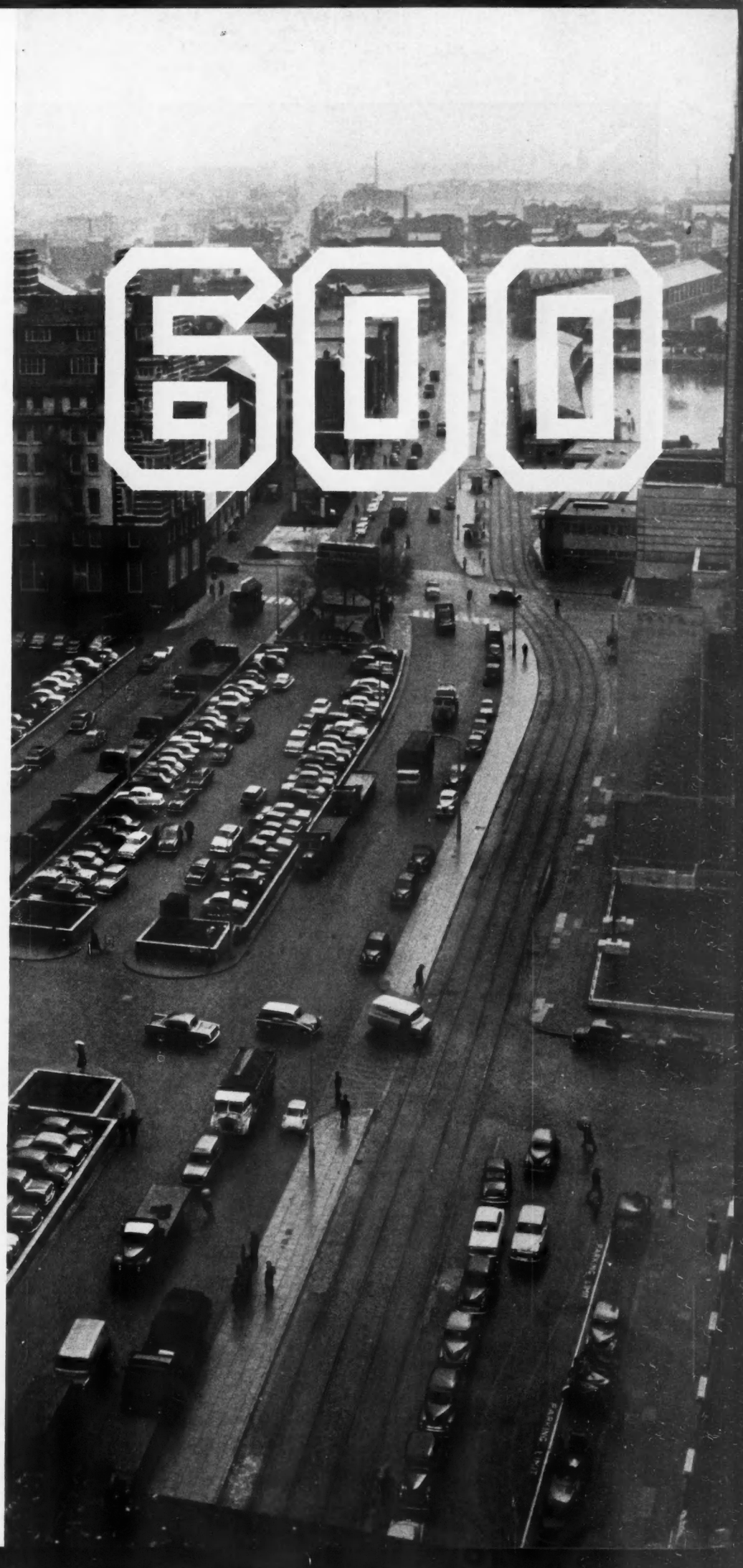

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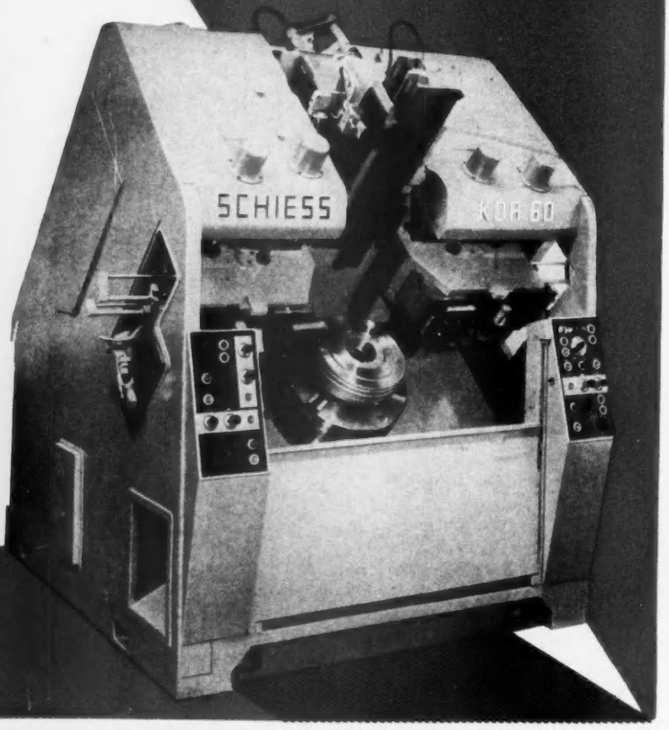

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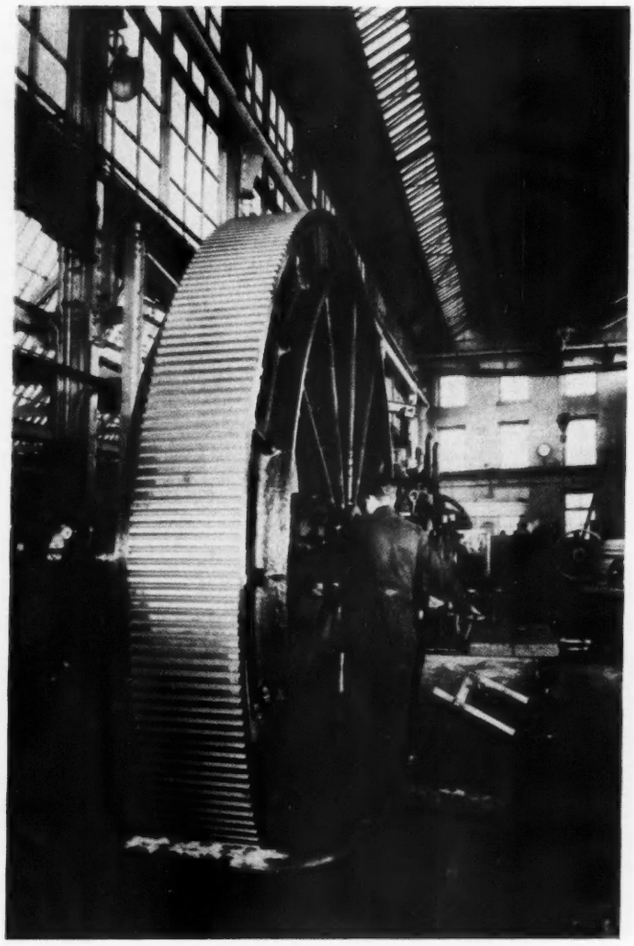

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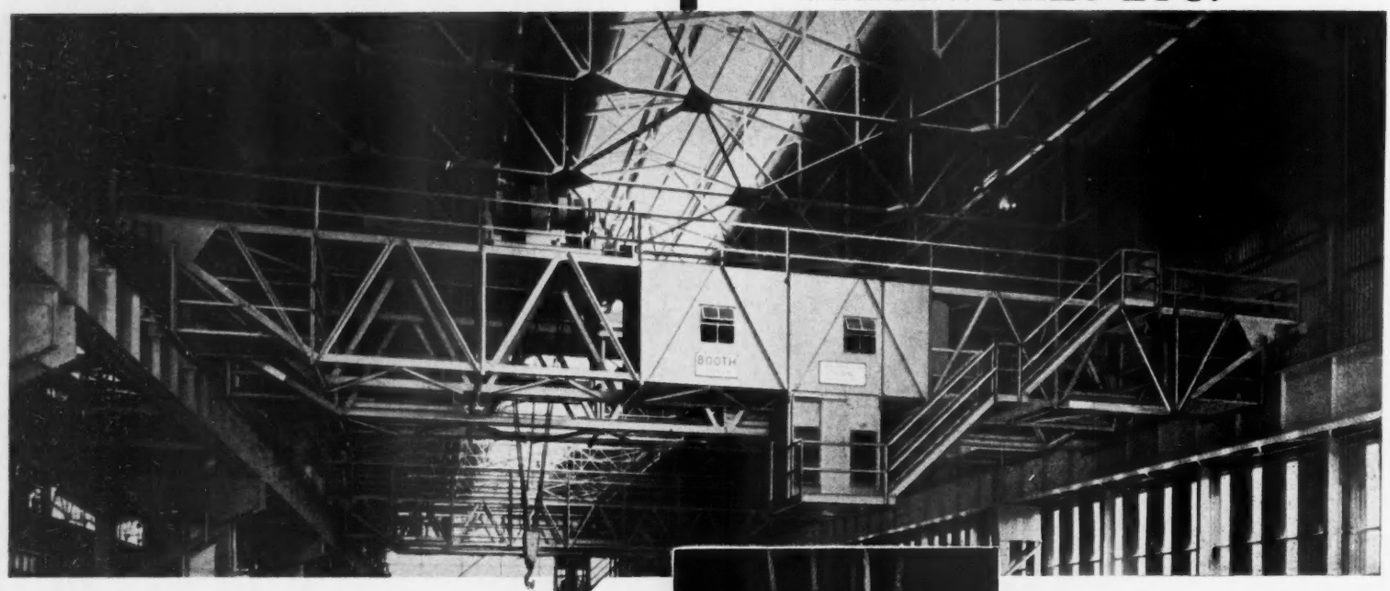
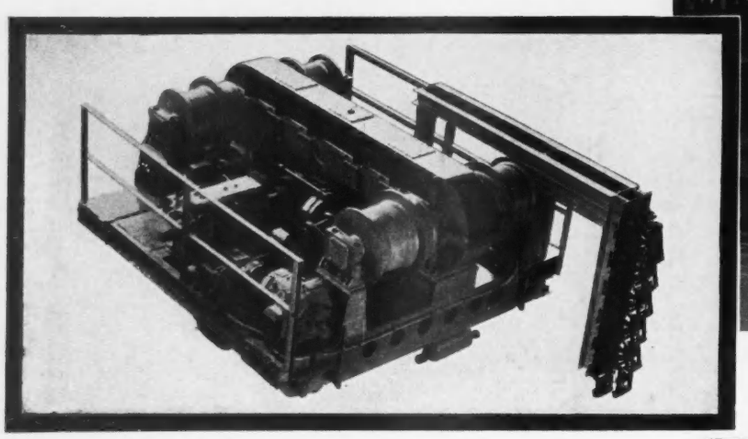


(ABOVE) Clyde Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.
(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.
(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Please ask for information on our range of cranes.

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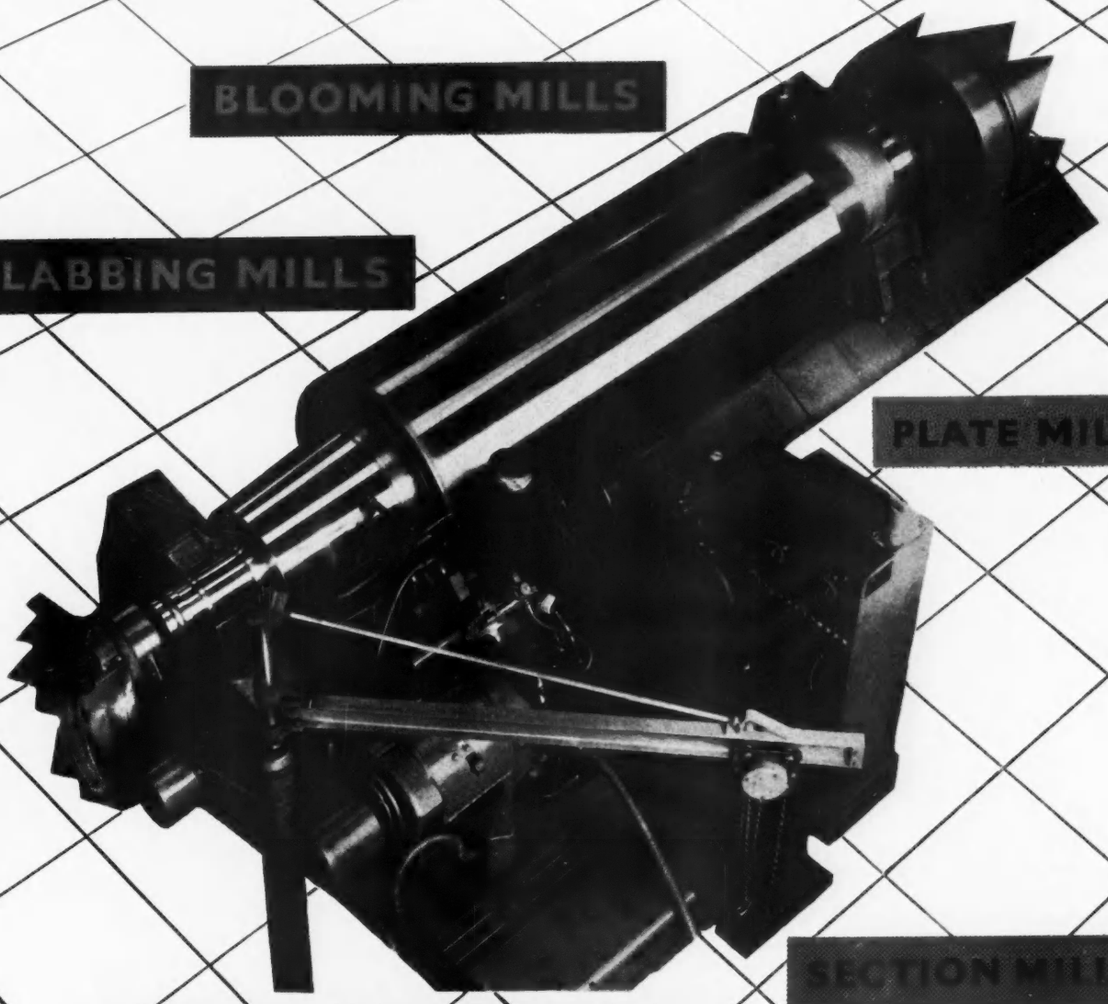

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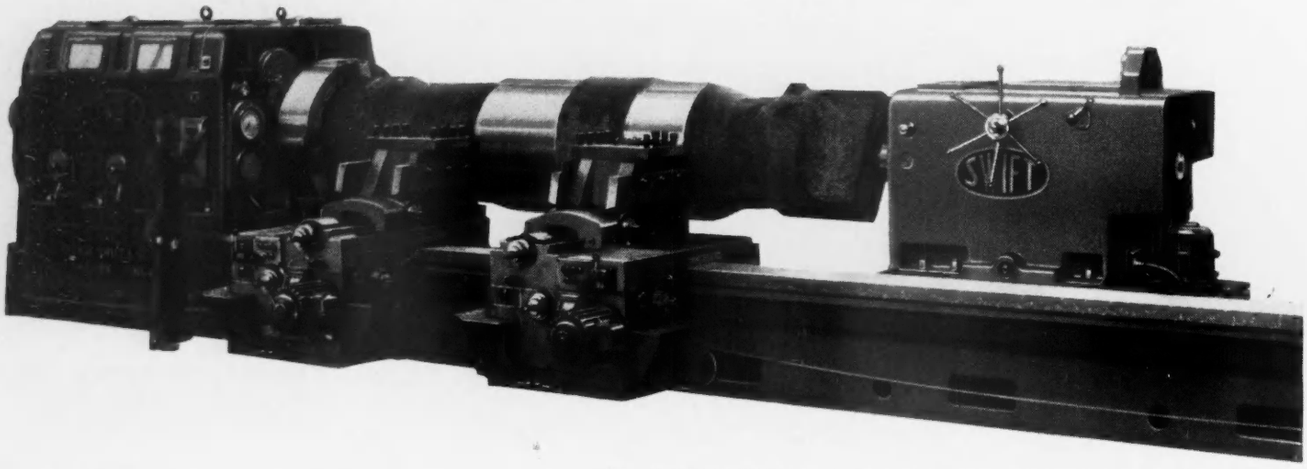
DARLINGTON

NEW SWIFT

HEAVY DUTY ROLL TURNING LATHE

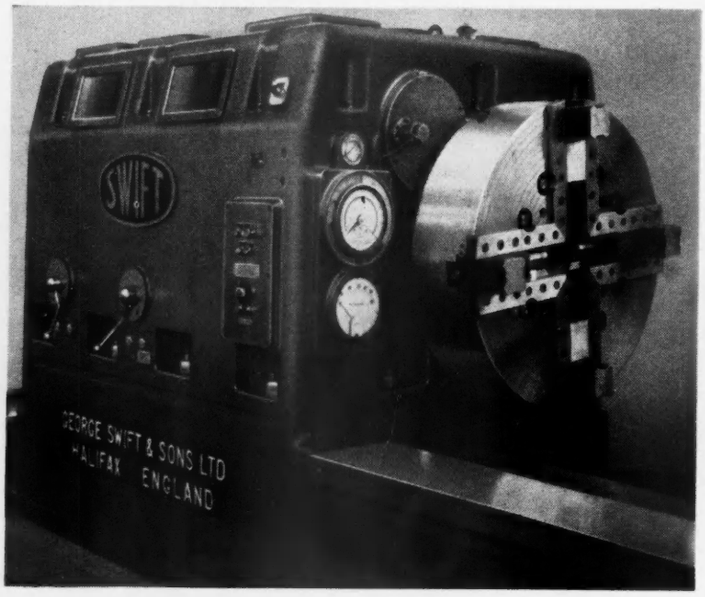


Specially designed for turning chilled iron and steel rolls, this new Swift Type R.L.3 lathe incorporates the most up-to-date features to ensure accurate production of work over a long period of service.

The drive is by means of a Ward-Leonard Set with an 8 to 1 overall range. The headstock illustrated on the right is a powerful all-geared type which, in conjunction with the 100 h.p. D.C. variable speed motor provides an overall speed range from ½ to 48 r.p.m.

The slides are arranged to traverse past the tailstock so that for finishing cuts the left-hand saddle can be traversed the full length of the roll. The saddle and apron units have self-contained drives and thus the conventional feed box and shafting are eliminated.

MAXIMUM DIAMETER ADMITTED	LENGTH OF BED	ADMITS BETWEEN CENTRES	SPINDLE SPEEDS IN CONJUNCTION WITH AN 8 : 1 VARIABLE SPEED MOTOR
42″	30′ 9″	18′ 0″	¾ to 6 r.p.m. 3 to 24 r.p.m. 1½ to 22 r.p.m. 6 to 48 r.p.m.



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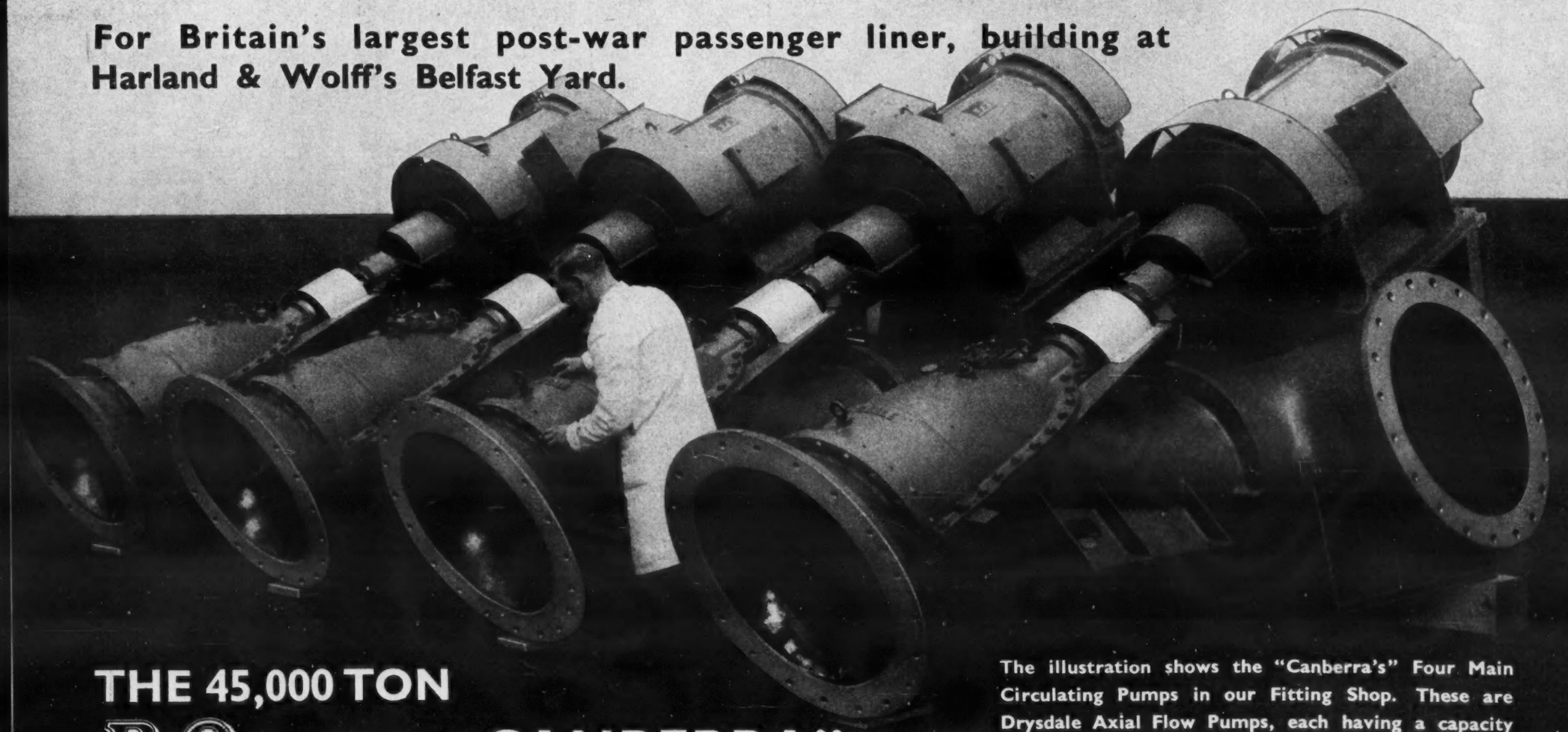

THE 45,000 TON P&O VESSEL "CANBERRA"

The illustration shows the "Canberra's" Four Main Circulating Pumps in our Fitting Shop. These are Drysdale Axial Flow Pumps, each having a capacity of 32,000 g.p.m.

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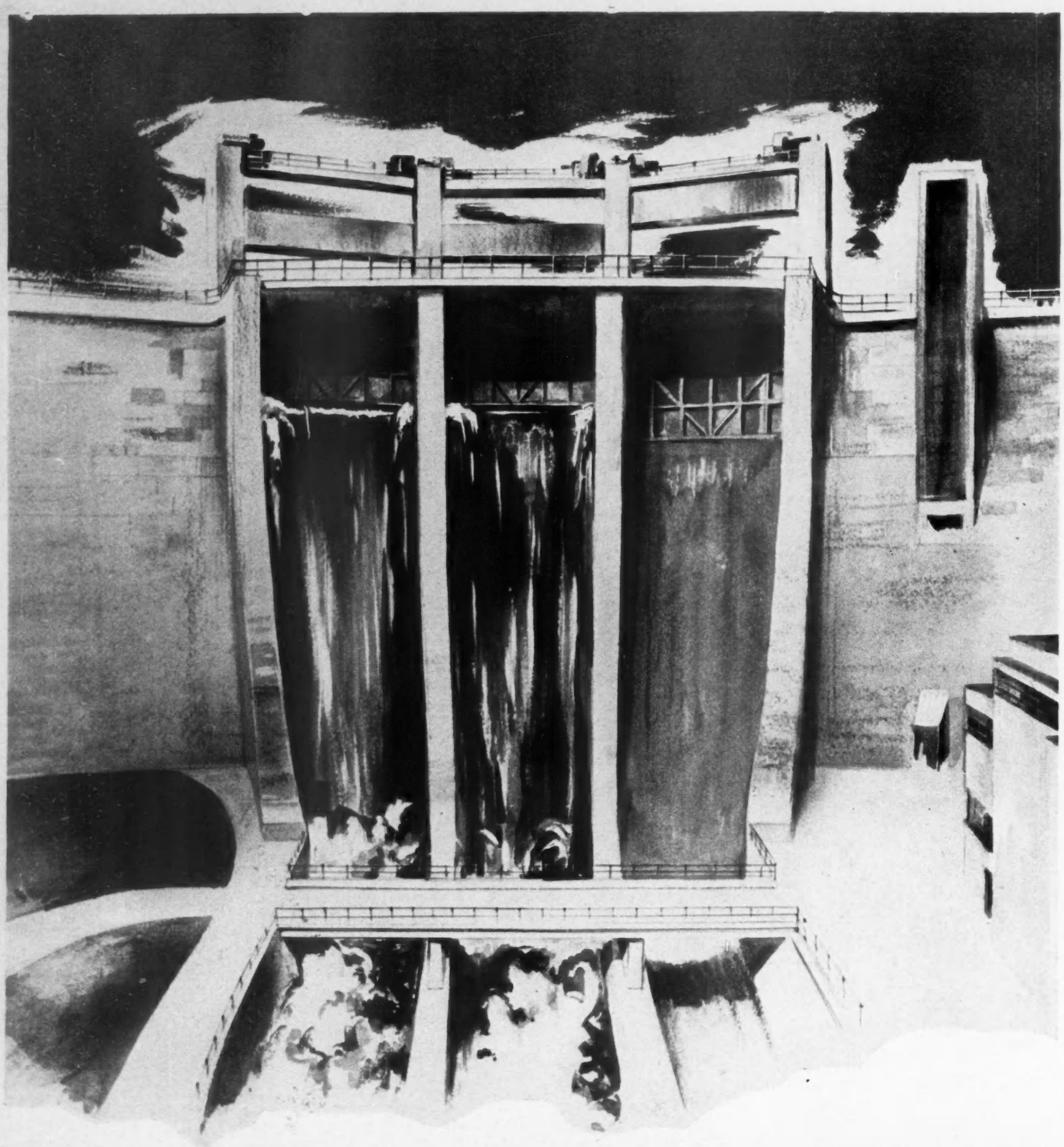

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AEI

Four AEI waterwheel alternators at the New Zealand Electricity Department's Roxburgh Power Station are already feeding 160,000 kW into the South Island grid. Four additional sets, to bring the station up to its designed capacity of 320,000 kW, are now in course of construction.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

HEAVY PLANT DIVISION RUGBY AND MANCHESTER, ENGLAND

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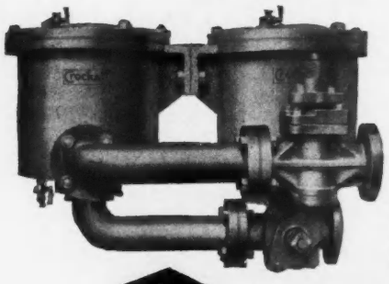
FEED WATER FILTER



The CROCKATT Feed Water Filter is available for high or low pressure in sizes up to 5in. bore. Removes suspended impurities, such as oil, grease, etc., from the feed water. Filter mats quickly and easily changed.

Also: Electric Salinometers, Boiler Tube Brushes Floor Sanders, Terazzo Surfacers etc. List on request.

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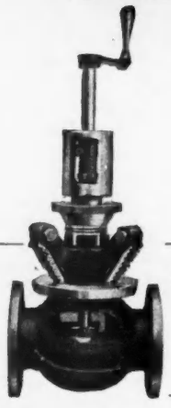

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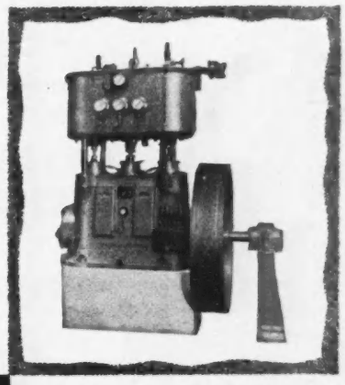

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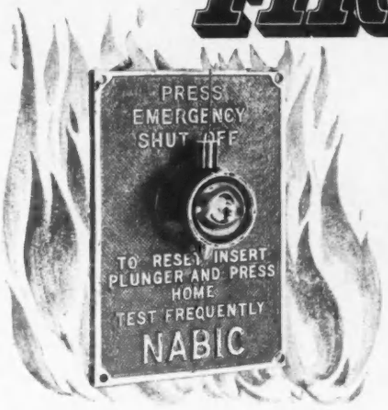
IN CASE OF FIRE

Can the oil supply to your Boiler House be "shut-off" quickly?



The fitting illustrated has been specially designed for the emergency shut-off of the Fire Valve and to permit regular testing of the Fire Valve. It should be placed as near to the Boiler House door as possible.

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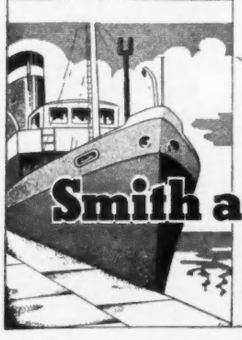

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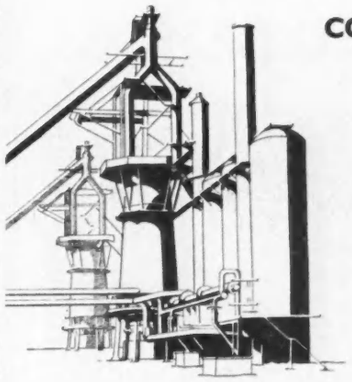

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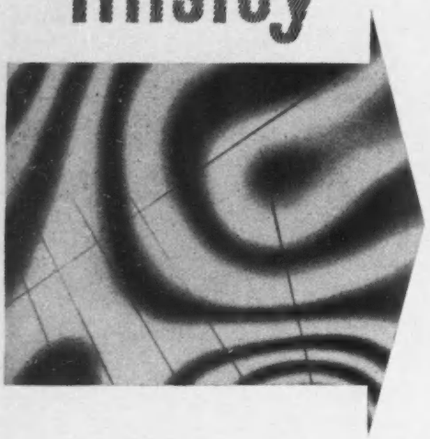

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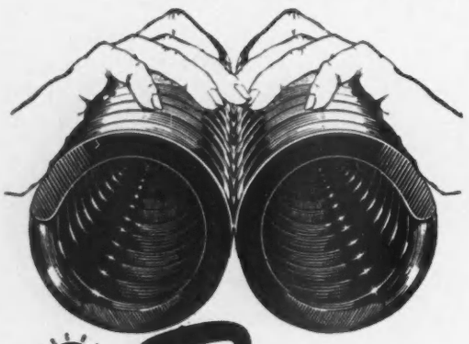

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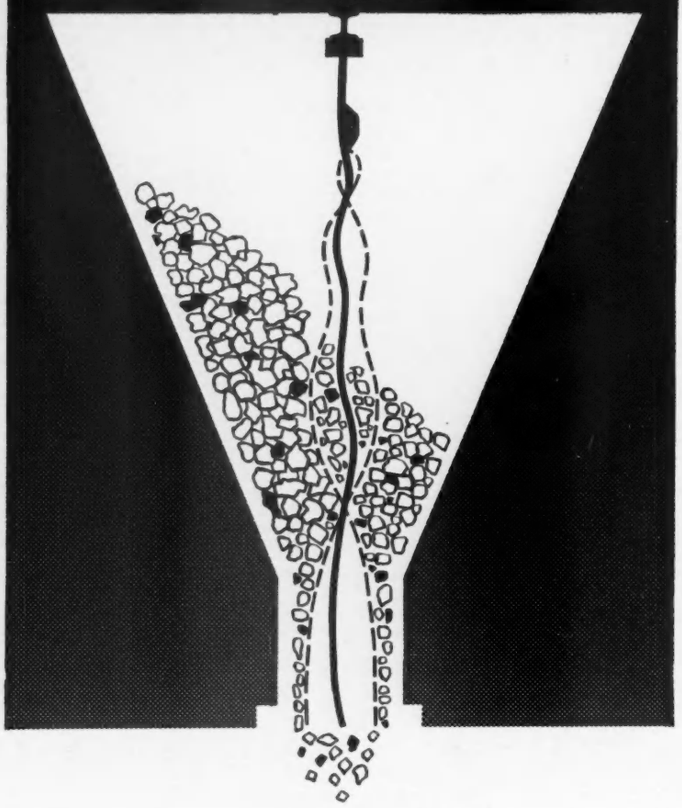

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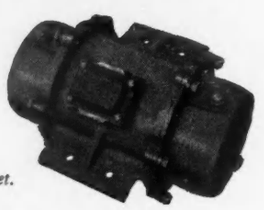

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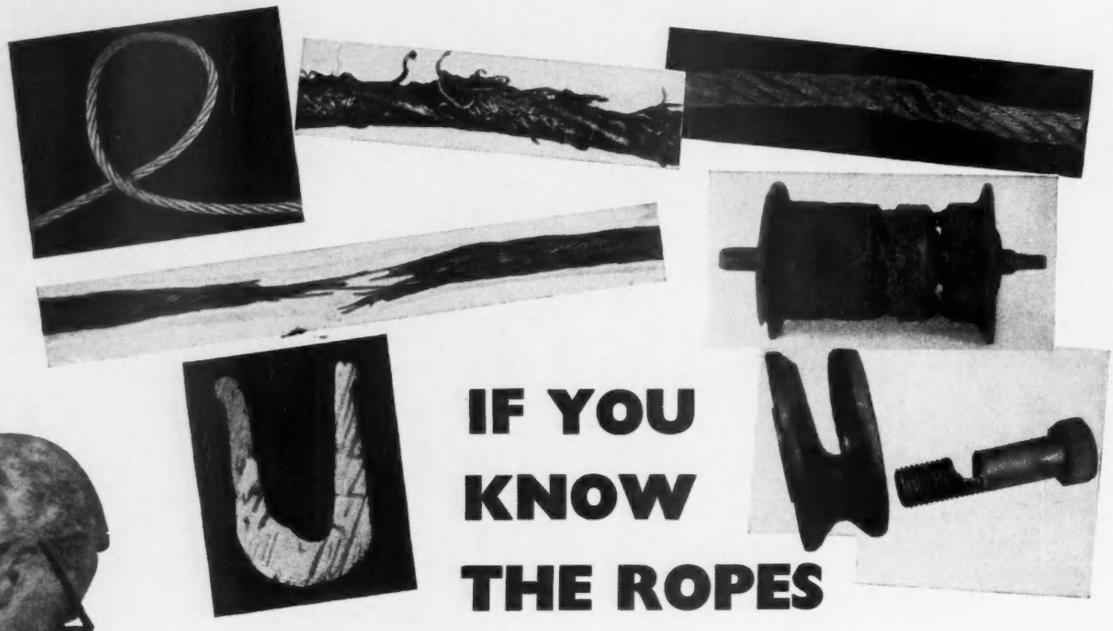

IF YOU KNOW THE ROPES

These photographs show some typical instances of damage to ropes and associated equipment caused by mishandling, wrong fitting or neglect. In each case serious damage was caused to the Wire Rope and considerable expense was involved in replacement and loss of output.

To prevent such occurrences and to help you to get long, safe life from your wire ropes we have compiled and published a series of papers *"Give Your Ropes a Chance"* which contains much useful and interesting information. We will be pleased to send you copies on request.

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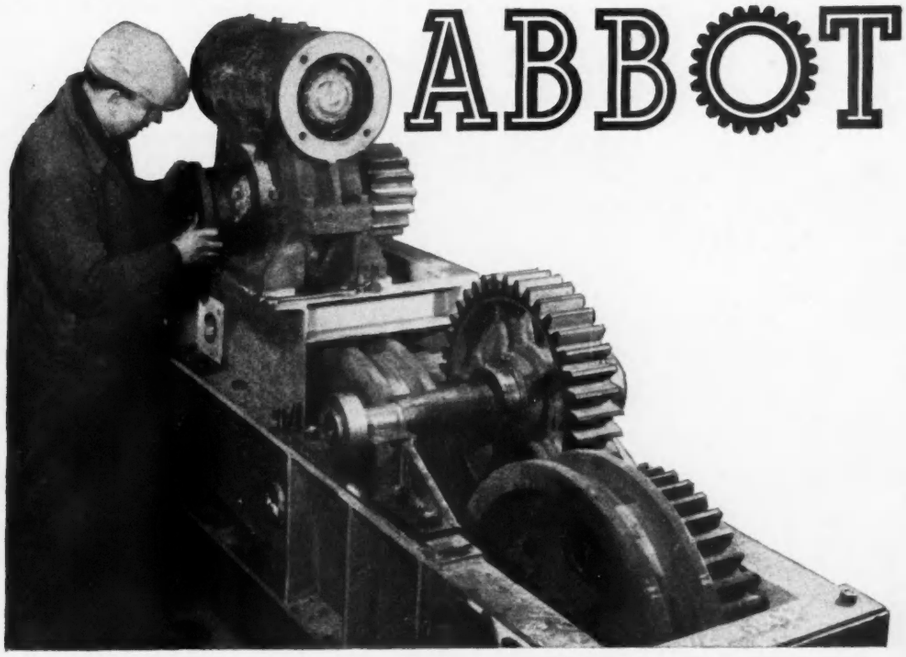

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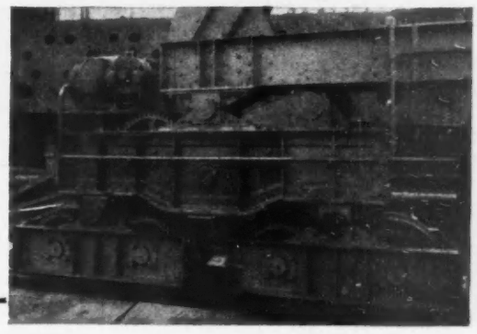

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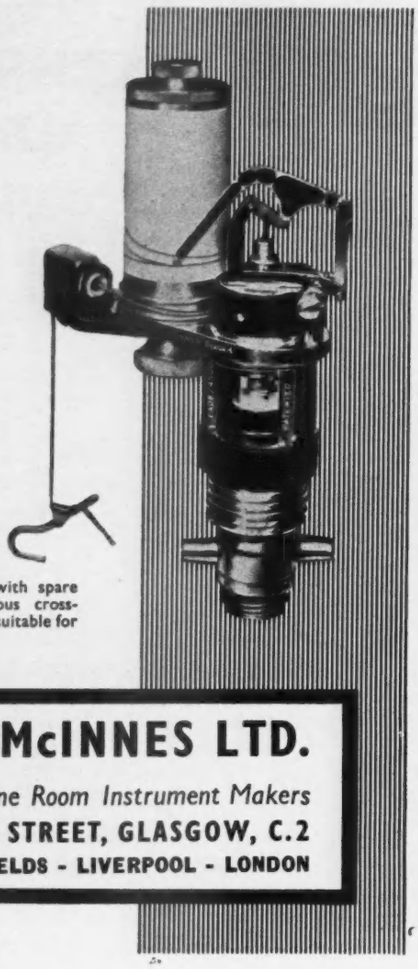

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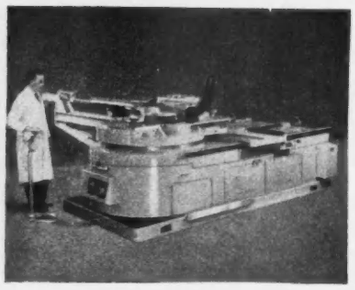

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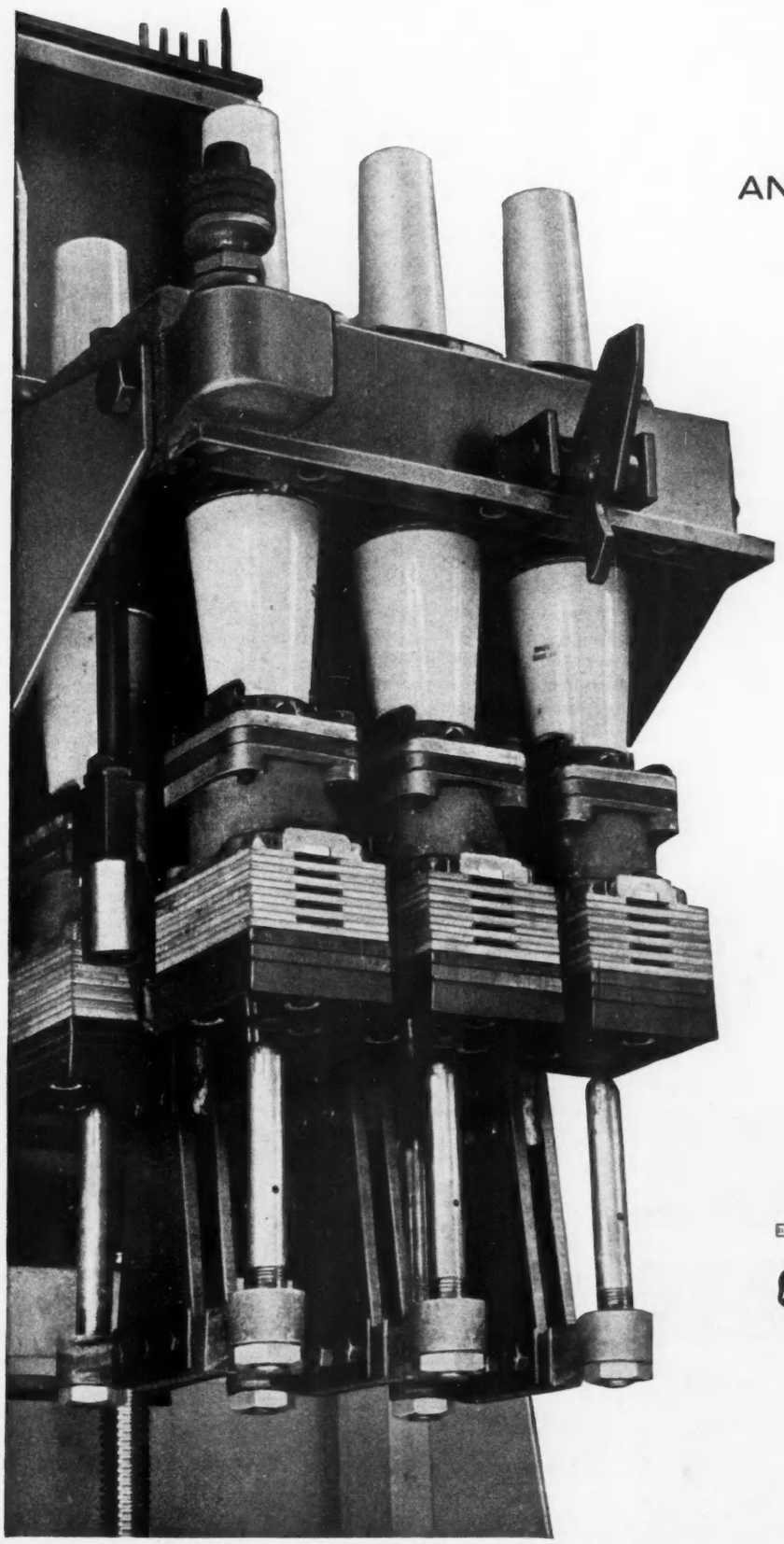

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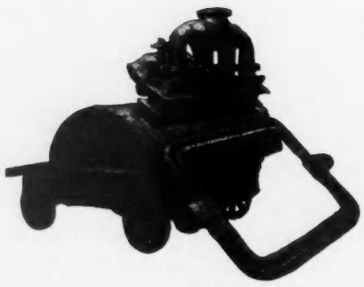

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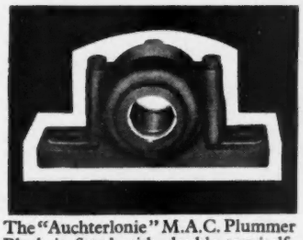

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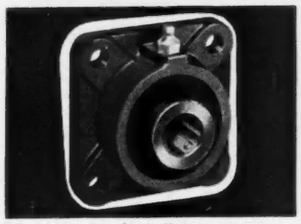

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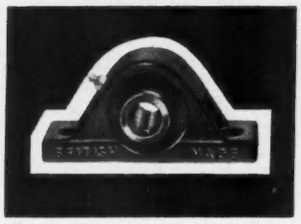

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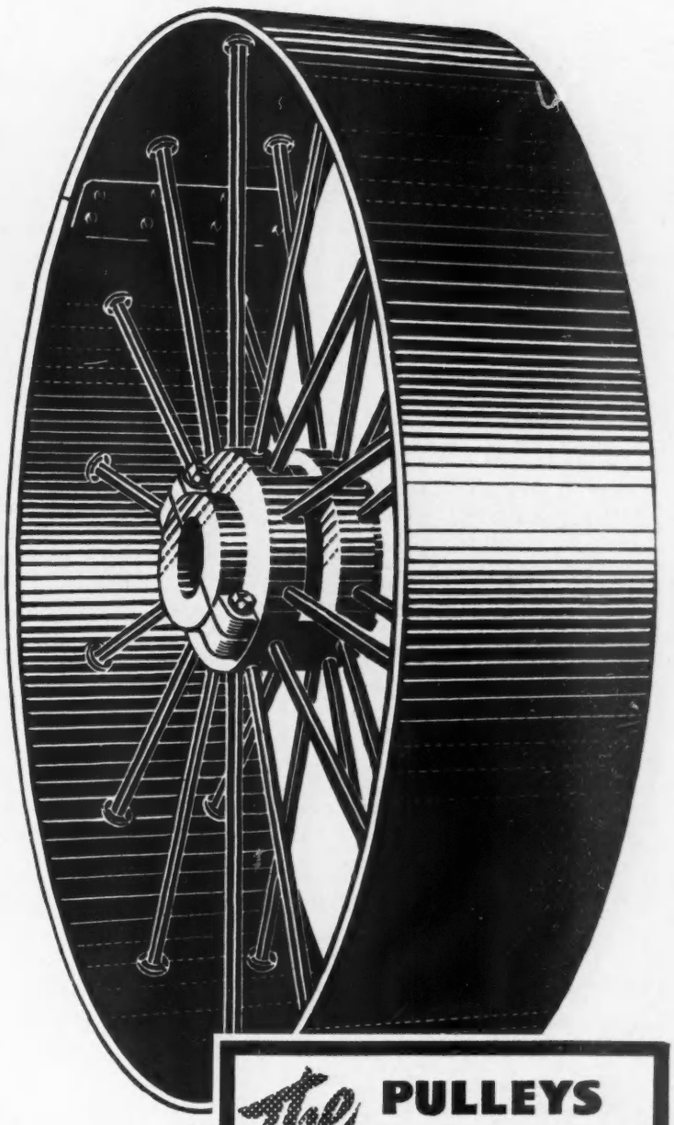

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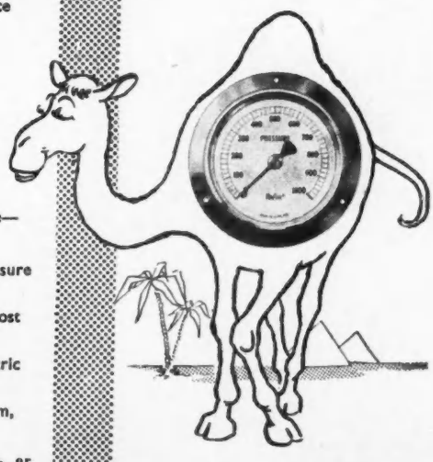

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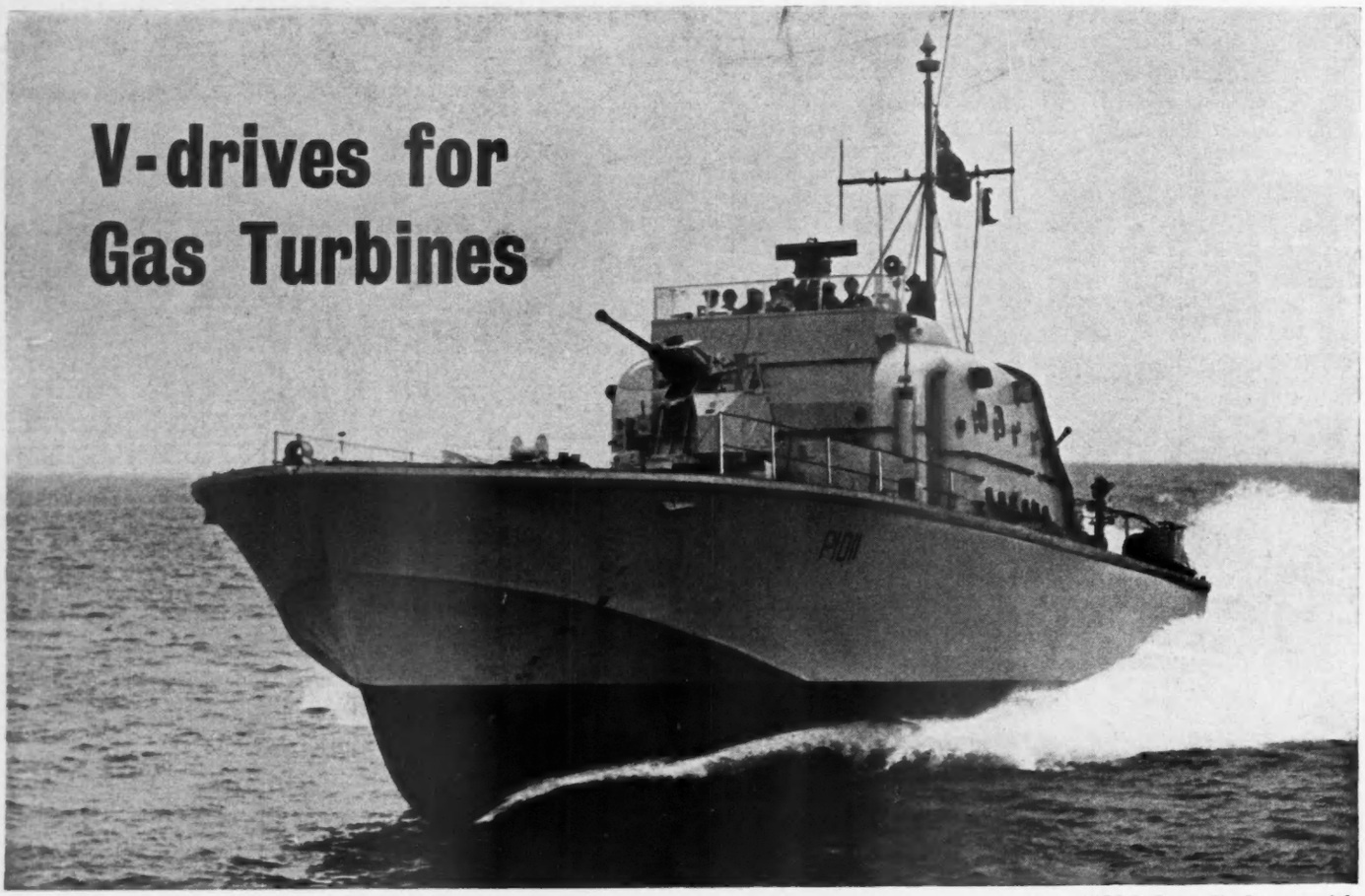

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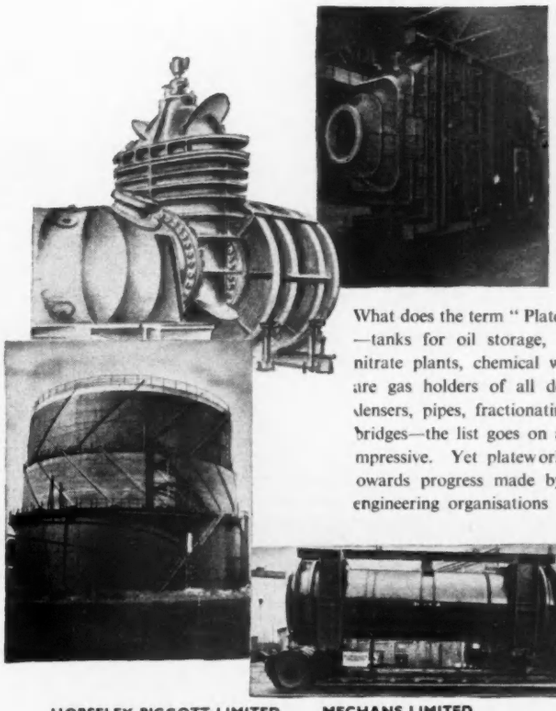

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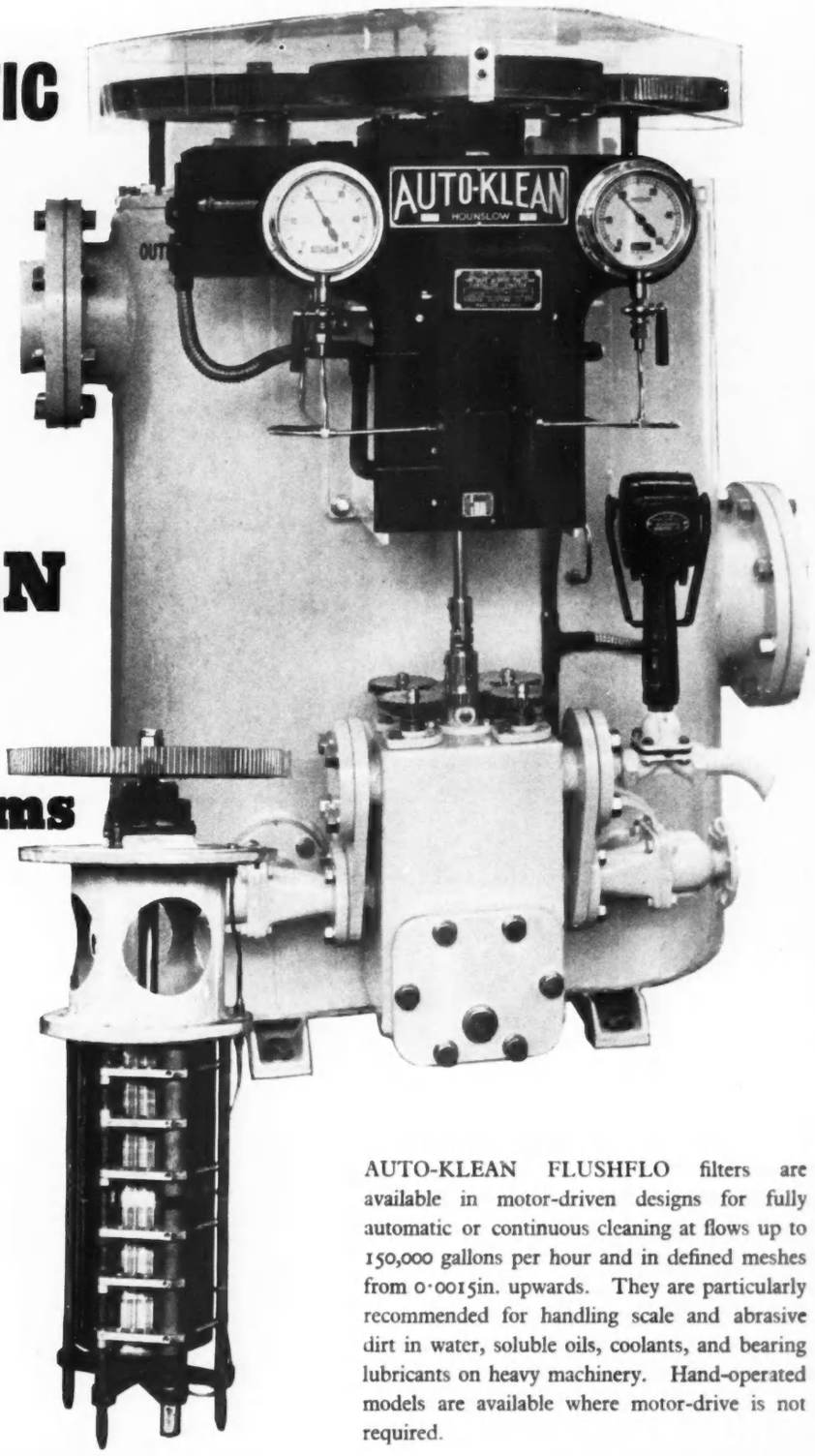

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